REVIEW OF MONETARY AND NONMONETARY VALUATION OF ENVIRONMENTAL INVESTMENTS

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PREFACE

This study was conducted as part of the Evaluation of Environmental Investments Research Program (EEIRP). The EEIRP is sponsored by the Headquarters, U.S. Army Corps of Engineers (HQUSACE). It is jointly assigned to the U.S. Army Engineer Water Resources Support Center (WRSC), Institute for Water Resources (IWR), and the U.S. Army Engineer Waterways Experiment Station (WES), Environmental Laboratory (EL). Mr. William J. Hansen of IWR is the Program Manager and Mr. H. Roger Hamilton is the WES Manager. Technical Monitors during this study were Mr. John W. Bellinger and Mr. K. Brad Fowler, HQUSACE. The Field Review Group members that provide overall Program direction and their District or Division affiliations are: Mr. David Carney, New Orleans; Mr. Larry M. Kilgo, Lower Mississippi Valley; Mr. Richard Gorton, Omaha; Mr. Bruce D. Carlson, St. Paul; Mr. Glendon L. Coffee, Mobile; Ms. Susan E. Durden, Savannah; Mr. Scott Miner, San Francisco; Mr. Robert F. Scott, Fort Worth; Mr. Clifford J. Kidd, Baltimore; Mr. Edwin J. Woodruff, North Pacific; and Dr. Michael Passmore, Walla Walla. The work was conducted under the Monetary and Other Valuation Techniques Work Unit of the EEIRP. Mr. Hansen of IWR and Mr. John Titre, Resources Analysis Branch (RAB), Natural Resources Division (NRD), EL are the Principal Investigators.

The work was performed by Planning and Management Consultants, Ltd. (PMCL), under Task Order 0065, Contract No. DACW72-89-D-0020. Dr. Timothy D. Feather of PMCL was the Principal Investigator and author in collaboration with Dr. Clifford S. Russell of the Vanderbilt Institute for Public Policy Studies, Vanderbilt University, and Mr. Keith Harrington and Mr. Donald T. Capan, both of PMCL. In addition, an interdisciplinary team was assembled by PMCL to provide background conceptual papers as part of this effort. Team members and the discipline each represented included: Dr. Daniel Willard, Indiana University, ecology; Dr. James Heaney, University of Colorado, environmental engineering; Dr. David Schkade, University of Texas, psychology; and Dr. Leonard Shabman, Virginia Polytechnic Institute and State University, resource economics.

The report was prepared under the general supervision at IWR of Mr. Michael R. Krouse, Chief, Technical Analysis and Research Division; and Mr. Kyle E. Schilling, Director, IWR; and at EL of Mr. H. Roger Hamilton, Chief, RAB; Dr. Robert M. Engler, Chief, NRD; and Dr. John W. Keeley, Director, EL.

At the time of publication of this report, Mr. Kenneth H. Murdock was Director of WRSC and Dr. Robert W. Whalin was Director of WES. Commander of WES was COL Bruce K. Howard, EN.

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I. INTRODUCTION

BACKGROUND

The U.S. Army Corps of Engineers (Corps), as a major land and water resource manager now becoming aligned with a newly enhanced environmental mission, is challenged with developing an evaluation system for proposed environmental projects. In the past, the Corps was primarily concerned with the development of water resource projects that increased economic production/development, often at the expense of degrading the natural environment and its functions. This has since been recognized, and the Corps is trying to reach more of an equilibrium between economic development and environmental integrity for water projects. That is, there is a shift of project emphasis from economic development to a broader analytical scope, including environmental restoration and mitigation. Implicit in this is the necessity for considering the entire vector of services of water resources projects and potential trade-offs.

Placing value on the environment, whether through monetary-based methods or through other evaluation techniques, has been and will be a widely researched topic for many years. This topic is intriguing from an academic research perspective and very important from the land and water resource management perspective. While no agency, academic discipline, or research entity can claim the "right answer" to the environmental evaluation challenge, the Corps seeks to uncover, organize, and build upon the foundations of existing approaches to better understand which can reasonably be used and is open to well-substantiated recommendations on an approach to the problem.

In support of this effort, the Corps is conducting research that will create tools for planners embarking on environmental projects. Following the traditions of project formulation and approval within the Corps, maximizing the outputs of the project for society and selecting the optimal combination of water resource development activities are the analytical and management challenges faced by Corps decision-makers. This research, called the Evaluation of Environmental Investments Research Program (EEIRP), is aimed at developing techniques that will respond to two important questions:

(1) How can the Corps determine whether the recommended action from a range of alternatives is the most desirable in terms of the environmental objective being addressed?

(2) How should the Corps allocate limited resources among many "most desirable" environmental investment decisions?

These two questions, referred to respectively as the "site" and "portfolio" questions, are being addressed through research conducted within the EEIRP work units shown in Table I-1.

TABLE I-1
EEIRP WORK UNITS

- Determining and Describing Environmental Significance
- Determining Objectives and Measuring Outputs
- Objective Evaluation of Cultural Resources
- Engineering Environmental Investments
- Cost Effectiveness Analysis Techniques
- Monetary and Other Valuation Techniques
- Incorporating Risk and Uncertainty into Environmental Evaluation
- Environmental Databases and Information Management
- Evaluation Framework

STUDY PURPOSE

This study, under the Monetary and Other Valuation Techniques work unit, is critical to meeting the Corps aim to consider the socioeconomic impacts of environmental efforts. The objectives of this EEIRP work unit over the next three years are to:

- Identify relevant socioeconomic use and nonuse values associated with environmental projects;

- Improve the linkages between environmental output measures and necessary inputs to socioeconomic evaluation;

- Develop, test, and provide guidance for nonmarket monetary evaluation of environmental project outputs; and

- Assess the appropriateness of nonmarket evaluation techniques for prioritizing programs at the national level.

The purpose of the initial year of study is to develop the conceptual foundation and institutional setting for pursuing further study tasks. The most prominent services of environmental projects and techniques for their assessment are reviewed. This review and discussion of Corps institutional constraints (e.g., expertise, time, authority) sets the stage for determination of which environmental evaluation techniques should be pursued. The specific objectives of the present effort are to:

- Describe services provided by environmental resources and systems and methods for their measurement or valuation;

- Review existing research programs and products; and

- Evaluate the resource constraints on field applications of measurement and valuation tools.

The present report documents the results of these review activities and outlines specific recommendations for further pursuit under the Monetary and Other Valuation Techniques and other work units of the EEIRP.

MONETARY VALUATION, NONMONETARY EVALUATION, AND DECISION FRAMEWORKS

Figure I-1 presents a generalized outline of the environmental investment decision process and the respective roles of monetary valuation and nonmonetary evaluation. Broadly, monetary valuation occupies the left side of Figure I-1 and refers to the processes which assign economic values to changes in ecosystem function/structure or socially-valued services, both of which can be considered outputs of environmental projects. The values estimated from these data and techniques can be used as inputs to benefit-cost-based decisions. Down the right-hand side of the figure, nonmonetary evaluation includes those techniques that assess in noneconomic terms the changes in outputs that result from environmental projects. Most nonmonetary evaluation techniques assess changes in ecosystem function/structure, but other measurements of ecosystem services, such as psychological value, are possible also. Nonmonetary evaluation techniques can serve as direct inputs to cost-focused decision analyses or as inputs to monetary valuation efforts. The elements of the environmental investment decision process as portrayed in Figure I-1 are described below.

Federal environmental investments include mitigation and restoration activities. These activities have construction and annual operations and maintenance costs associated with them. The investments are intended to change the condition of the particular environment and its function and/or structure. There are a variety of established ecological assessment techniques, such as the Habitat Evaluation Procedures (HEP), for evaluating changes in the character of the ecosystem for with- and without-project conditions.

The changes in ecosystem function and structure have direct implications for services that the ecosystem provides to society. Examples of such services are the flood control and water quality services of wetlands. Moving down the right side of Figure I-1, the change in function/structure and socially-valued services together comprise nonmonetary evaluation of changes in ecosystem outputs that result from environmental investments. These evaluations can be combined with project cost data in cost-focused analyses, such as cost-effectiveness or incremental analyses.

The ecosystem output assessment techniques can also serve as inputs to monetary valuation processes. The changes in function/structure and services can lead to changes in patterns of resource use. These new patterns are reflected in modified socioeconomic use valuations. The nonuse valuations of the environmental resources will also reflect the modified environmental conditions. These changes in use and nonuse values can be measured using established monetary valuation methodologies, including market-based, surrogate market, and

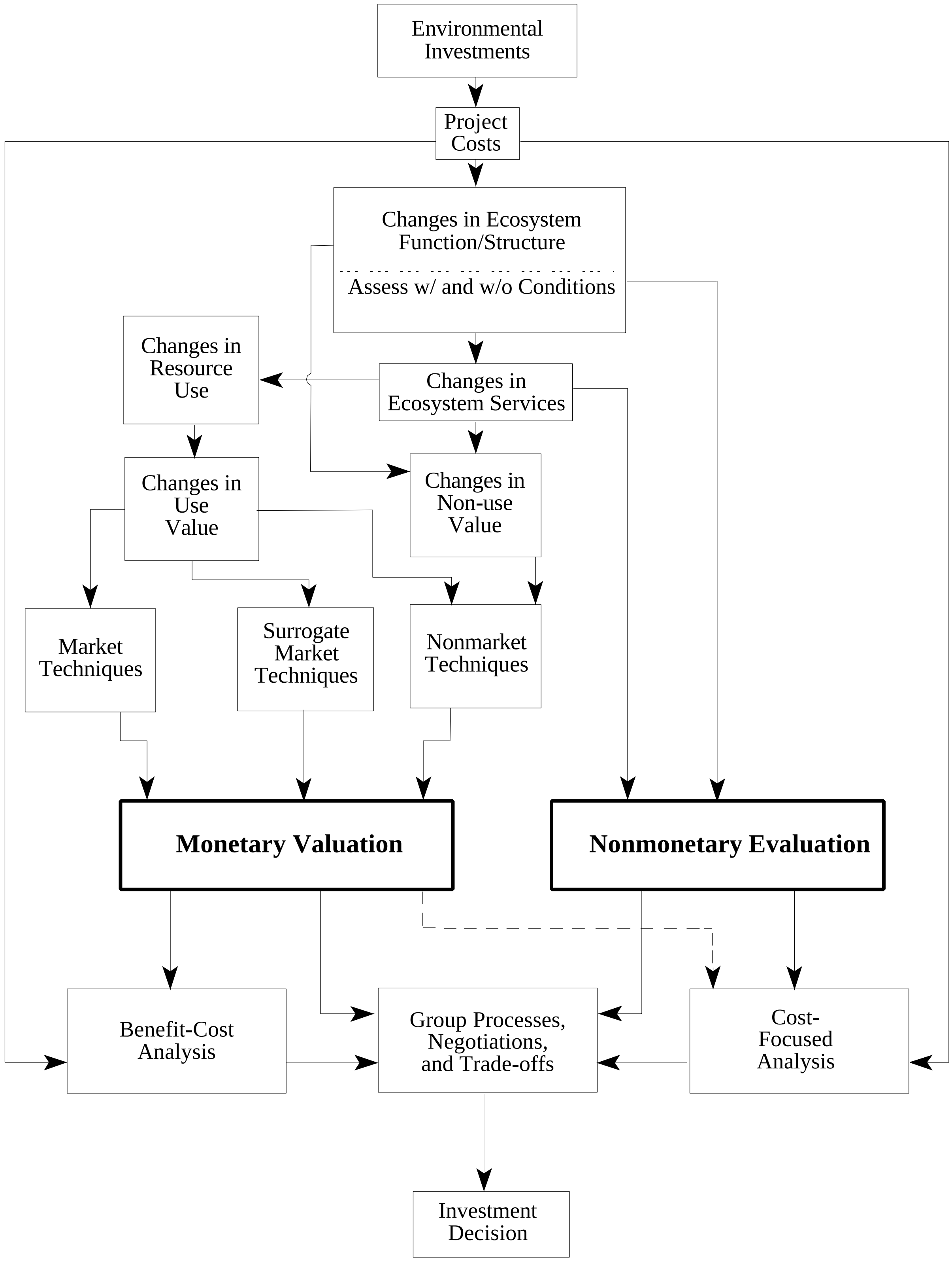

FIGURE I-1
GENERALIZED ENVIRONMENTAL EVALUATION PROCESS

nonmarket techniques. The market-based techniques include changes in factors of production and next best alternatives. Surrogate market techniques include the travel cost method and hedonics. Finally, among the nonmarket techniques are the contingent valuation method. The monetary valuations can then be combined with cost data into a benefit-cost analysis.

A dashed line connects monetary valuation to cost-focused analysis. This connection would be activated in the case of a multiple-purpose project that evaluates different objectives associated with monetary and nonmonetary techniques. For example, a flood control project may be combined with wetlands restoration into a multiple-objective project. In the cost-focused analysis of the wetland restoration effort, the potential loss or gain of flood protection associated with the restoration, calculated in monetary terms, would need to be considered as an additional cost (in terms of economic benefits foregone) or benefit (i.e., a net reduction in project costs).

Monetary valuations and nonmonetary evaluations are intended to serve as inputs to environmental investment decision processes. Final environmental investment decisions typically are reached via implicit or explicit trade-off analyses and negotiations between the various stakeholders. The results of the cost-focused and benefit-cost analyses may or may not be used as inputs to these group processes. The relationships between monetary valuation, nonmonetary evaluation, cost-focused analyses, and benefit-cost analyses are discussed briefly below.

Cost-Focused Analyses

Federal resource agencies are often directed to accomplish specific environmental goals through legislative or executive mandates. Calculations of the monetary benefits of such actions are therefore not required. The use and nonuse values of those environmental actions are implicit in the directive. Explicit monetary valuation of the benefits would be a costly ancillary exercise. The central task of decision making within this framework is to determine the most cost-effective means to achieve the stated goal. Cost-focused techniques typically do not produce a single optimal allocation of resources. Instead, solutions are identified for different decision parameters and constraints.

Nonmonetary evaluation techniques are very compatible with cost-focused analyses. There are three common ways in which nonmonetary evaluation techniques have been used in conjunction with cost-focused analyses. First, legislation may direct that a specific environmental goal be achieved for the least cost. An example of this combination would be the goal of the Federal Water Pollution Control Act (i.e. the "Clean Water Act) to achieve "fishable and swimmable" waters in the United States. Title II (Section 1298) of this act requires that "...the (water treatment) facilities plan of which such treatment works constitutes the most economical and cost-effective combination of treatment works over the life of the project to meet the requirements of this Act."

Second, as in cases of the incremental analysis procedures used by the Corps, the output levels of the project are not specified. If the goal is to construct freshwater wetlands, incremental analysis would be used to identify the plan that yields the greatest amount of wetlands per dollar expended for a given project scale and budget.

Finally, there are cases when the budget for the project is fixed, and a cost-focused analysis is conducted to develop a plan for the optimum expenditure of those funds to meet the specific environmental goal. This case is exemplified by the Coastal Wetlands Planning, Protection, and Restoration Act. The Act formed an interagency Federal task force to prepare a priority list for Louisiana coastal wetlands protection (Louisiana Coastal Wetlands Planning and Restoration Task Force, 1993). Again, there was no monetary valuation of the benefits of the environmental project. The benefits were implicit in the legislation, and the task force could therefore concentrate its efforts on how to do this most economically. In this case of cost-effectiveness analysis, outputs from the different project alternatives were estimated using nonmonetary evaluation techniques.

Benefit-Cost Analysis

In the same way that nonmonetary evaluation techniques are compatible with cost-effectiveness analysis, monetary techniques are particularly well-suited for benefit-cost analysis as a decision framework. Benefit-cost analyses differ from cost-focused analyses in that a single, optimal allocation of resources is identified, the project that maximizes the net addition to National Economic Development (i.e., the "NED" project).

There are new initiatives at the Federal level which could dramatically increase the role of benefit-cost analysis in Federal environmental decision making. One such initiative is the January 26, 1994 Executive Order, "Principles for Federal Infrastructure Investments", which requires Federal infrastructure investments, including environmental protection measures, to quantify and monetize benefits and costs "to the maximum extent possible." The degree to which other Federal agencies adopt benefit-cost analysis in the future is particularly uncertain at this time, given the Congressional realignment that resulted from the 1994 elections. Other uncertainties surrounding benefit-cost analysis are the recurrent attempts to reinvent government, such as *From Red Tape to Results: Creating a Government That Works Better and Costs Less* (referred to as the "Gore Report"). These critical reappraisals of the Federal government often cite government-wide applications of benefit-cost analysis as an important avenue to more efficient Federal investment. These uncertainties could prove to be very important developments for future research and application of monetary valuation techniques.

SCOPE

The scheme shown in Figure I-1 describes the general relationships between the elements of the evaluation process for environmental investments. Although their theoretical relationships have received considerable attention in the literature, progress toward settling on practical methodologies has been somewhat limited. This investigation examines the nature of this multifarious problem and identifies promising directions for developing practical tools that can be used by Corps planners who are challenged with placing values on or making prioritized decisions regarding the environment. The major elements of monetary valuation and nonmonetary evaluation are examined from several fronts in this study with the objective of finding pragmatic evaluation techniques for the Corps planner. This effort can be described as a virtually continuous process of seeking and gleaning approaches that are theoretically sound but developed to a stage that they can be used practically by the Corps planner.

Academic Panel Examining Problem

Evaluation of the environment has received input from a range of academic perspectives. To accommodate this range of perspectives, a panel was assembled representing the major academic disciplines concerned with the environmental evaluation challenge. Representing the field of resource economics on the panel was Dr. Clifford Russell, the director of the Vanderbilt Institute of Public Policy Studies and Professor of Economics and Public Policy at Vanderbilt University. Dr. Russell serves on several environmental research and academic committees and presently serves as President of the Association of Environmental and Resources Economists. The other economist on the panel was Dr. Leonard Shabman, Professor in the Department of Agricultural and Applied Economics at Virginia Polytechnic Institute and State University. Dr. Shabman is a long time consultant and advisor to many resource agencies including the Corps, for which he recently authored *Environmental Activities in the Corps of Engineers Water Resources Programs: Charting a New Direction*.

Dr. Daniel Willard of the Indiana University School of Public Affairs provided the panel with the ecologist's perspective. Dr. Willard has served on several nationally recognized panels, including the National Research Council's Committee on Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy.

Dr. James Heaney represented the engineering perspective on the panel. Dr. Heaney is presently Professor in the Department of Civil, Environmental, and Architectural Engineering at the University of Colorado. Much of Dr. Heaney's environmental engineering research was conducted while he directed the Florida Water Resources Research Center.

Finally, representing the field of psychology, was Dr. David Schkade, Associate Professor of Management in the Graduate School of Business at the University of Texas, Austin. Dr. Schkade brought to the panel the perspective of the psychology of decision-making with special emphasis on environmental preferences.

This panel of experts was charged with putting forth their views on how the Corps should approach environmental evaluation and related planning challenges. Four of the panelists developed papers representing their academic and professional perspectives on the problem. The papers by Heaney, Schkade, Shabman, and Willard are found in their entirety in the appendices of this report. The reader is encouraged to take time to review the appendices as they fully present many of the arguments and points made in the main text. The perspectives offered in the four papers were compared and contrasted by Dr. Russell in a summary discussion of the problem which is Chapter II of this report.

Besides providing expositions of the disciplinary perspectives on environmental evaluation, the opportunity for the panel members to discuss the issues during two meetings was very valuable. Through these meetings, the panel members were able to better understand the problem, as well as clarify the short-comings and offerings of their respective tool chests for environmental evaluation in the Corps. In the first session, a general discussion of the technical issues and project purpose was held with representatives from the Corps and the panel. The scope of work was presented and questions related to the intent of the effort were discussed. Fundamental positions regarding monetary valuation and nonmonetary evaluation were identified. The first meeting concluded with the writing assignments for each of the panelists. Another meeting was held after the individual papers had been written and summarized by Dr. Russell. Points of clarification and further discussion were offered as were specific recommendations for further research for the Corps EEIRP with the focus on the Monetary and Other Valuation Techniques work unit. The recommendations offered at the final session form the basis of the recommendations offered in Chapter V. One attribute of the problem that was agreed upon by nearly all involved was that no single discipline can accommodate the complexity of environmental evaluation and, therefore, extensive interchange between the disciplines is needed.

Federal Agency Perspectives

Another front explored in this study is that of other Federal resource agency perspectives. A review of their missions, operations, and research related to environmental evaluation is provided. Certainly, precedence in Federal water resources management would lend itself to some technical direction in the Corps search for planning tools. Research programs of other resource agencies are reviewed and discussed in terms of their applicability to the Corps environmental planning challenge.

Corps Institutional Constraints

The Corps operates under certain mandates, both external legislation and internal regulations, which have direct impacts on what tools might be appropriate for environmental evaluation. Although a certain technique may yield a defensible approach to an environmental planning challenge, the technique may not be applicable because of the institutional constraints. In other cases, data or personnel may not be appropriate to feed or execute a particular technique. The pertinent features of the Corps institutional structure are examined and described and conclusions regarding these institutional impacts as they infer the appropriate set of environmental evaluation methods are offered.

SUMMARY AND ORGANIZATION

As an analytical pursuit, the evaluation of environmental resources is presently fragmented, but the diverse perspectives are beginning to converge. The individual papers by the panelists (which are provided essentially unedited in the appendices of this report) display this fragmentation in terms to the technical positions they respectively purport, and in some instances, utilize different terminology to describe the same concept. The Federal agencies' research outlined in this study are at different stages of the learning curve regarding environmental evaluation, given their traditional management activities and research agendas. Even within the Corps Districts and throughout the Corps hierarchy there are differing levels of environmental expertise and philosophical perspectives. It is therefore no surprise that the present report is somewhat discontinuous in its arguments, as it reflects the state of environmental evaluation. The purpose of this report is to identify basic ideas, arguments, and constraints, and further, to give direction to the Corps planning community regarding the more promising avenues for its environmental evaluation activities.

This report examines the perspectives of environmental evaluation on three fronts as shown in Figure I-2. The panel assembled for this study provides the academic perspective, although the other two fronts illustrated in Figure I-2 are also influenced by academic perspectives presented in Chapter II (Russell), Appendix A (Heaney), Appendix B (Schkade), Appendix C (Shabman), and Appendix D (Willard). The research and operational activities of other resource agencies are reviewed in Chapter III. The front described as Corps institutional constraints considers the technical and operational realities of the Corps in the environmental evaluation challenge (Chapter IV). Each of these fronts contributes to a better understanding of the problem and leads to a set of recommendations for further research in these issues (Chapter V).

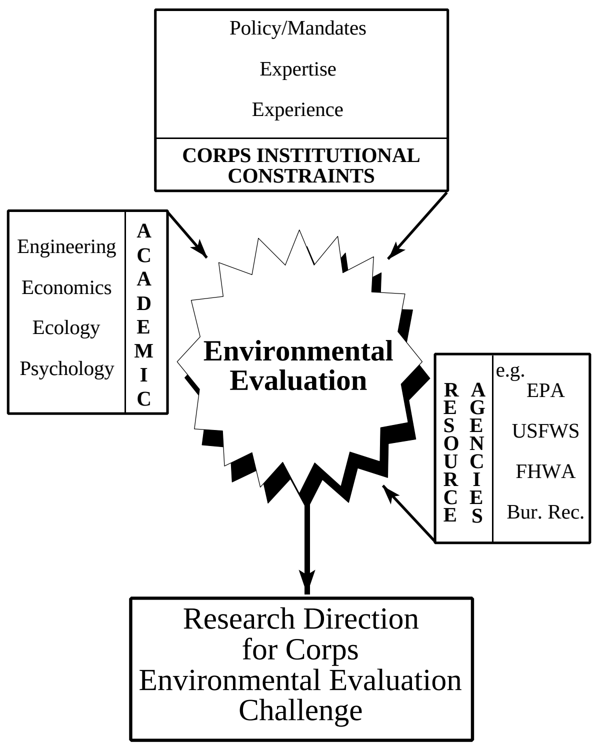

FIGURE I-2
RESEARCH ACTIVITIES IN THIS INVESTIGATION

II. DISCUSSION OF THE PROBLEM

INTRODUCTION

Broadly speaking, the purpose of the set of papers at the appendices is to provide the Corps leadership and field personnel with the perspectives of four different disciplines —ecology, economics, engineering and social psychology—on the questions of how judgments should be made among alternative environmental restoration projects. Such projects may be large, as in the unstraightening of the Kissimmee River, or small, as when some minor change is made to a culvert or road in order to correct the flow regime in a locally important wetland. Generically, environmental restoration projects modify or even destroy features of earlier structures—or possibly change operating regimes—so that elements of the natural world are returned to a condition more closely approximating the pre-intervention situation. Removal of a dam or a levee are simple examples, at least in the sense that the restoration actions are easy to understand. A change in reservoir operating rules to restore pre-dam flow patterns may be more complicated. The restoration of pre-channelization meanders might involve miles of carefully planned and executed diking and cutting. All involve attempts to recapture at least some features of the past.[1]

In sum, while the outputs from restoration projects are difficult to predict and value—at least they are far harder to deal with than such traditional outputs as navigation, flood damage reduction, and hydroelectric power—the pressures on Corps budgets from both Congress and the executive branch are greater now than in the past. These pressures imply that in this area of construction and operation, as in every other, the Corps must seek a method of building its budget that is externally defensible; internally reproducible as project proposals pass up the line from field offices, through Districts and Divisions, to Headquarters; and that allows comparison across projects of different types from different places.[2]

Corps Environmental Investment Decision Contexts

It will be significant later in this effort at the interpretation and integration stage to recognize that internal reproducibility and external defensibility are, to a significant extent, independent characteristics of a decision method. That is, some set of arbitrary rules might be highly reproducible

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[1] As Shabman points out in his paper (Appendix C), it makes a considerable difference to the analytic and decision problem just what objective is chosen for the restoration project. Using an example from the Everglades, he contrasts several alternative possibilities: restore a water flow regime; restore patches of a particular habitat type; or restore populations of particular bird species. This subject will be explored in greater detail.

[2] It has been pointed out that currently there are insufficient projects submitted to exhaust the annual funding available for restoration projects under section 1135(b) authorization (Water Resources Development Act of 1986), making the need for comparability at least less crucial.

up the chain of command but indefensible in other settings (for example, increased local employment/spending and other "stemming" benefits). On the other hand, a process of negotiated agreement at the local level might be defensible (Shabman and Schkade both sketch the elements of such a defense) but essentially irreproducible. As for the comparability requirement, reproducibility seems to be a necessary, but by no means sufficient, precondition. For example, if every district or division used a different, but reproducible, decision process, comparisons would only be possible within each local system.

These characteristics are demanded of the ranking or decision method because of the organizational structure of the Corps and its place in the national political scene. The following elements of that place seem especially important:

- The Corps remains a decentralized organization, with significant initiative residing in the field.

- There exists, however, a multi-layered process of review and approval that puts the power to stop or modify projects in the hands of levels above the field.

- Overall, the Corps is increasingly subject to OMB budget review and needs to be seen as a team player within the Administration.

- Capital projects require, with few exceptions, the financial support of local sponsors, who must, therefore, literally buy into whatever is to be done.

The above constitutes the constraints or limits on Corps action in general. However, environmental restoration has considerable *a priori* appeal as an activity area for the 1990s and beyond. The very fact that the Corps has lost the power to impose water "control" projects on regions with the enthusiastic backing of Congress, reflects in part the growing power of environmentally concerned groups at the local, regional, and national levels. Restoration responds to these groups' concerns and has the potential to earn the Corps favor if it enters the field with the right tools and attitudes.

Example of the Challenge

As an example, consider the West Tennessee Tributaries project. This attempt to control flooding along tributaries of the Mississippi in west central Tennessee was authorized in 1948. Channelization began in 1961, but by 1970, the project was in trouble with environmentalists who by then had the power to litigate. A series of court actions followed and slowed progress on this line of work so that by 1994, only 41 percent of the authorized channelization was complete.

In 1992, the Governor of Tennessee began a local negotiation process, with the committee chair coming from the state planning office. Represented were local communities, local and state environmental organizations, farm and forestry trade associations, interested state and Federal agencies, including the Corps and EPA, and plaintiffs from the lawsuits. This "steering committee," as it was called, produced a consensus report calling for a redesigned project, one "designed to return more natural functions to significant reaches of the river flood plains. In these restoration reaches, a naturally meandering river channel capable of carrying normal flows would be restored..." and would "also include protected and restored wetland areas whose natural functions attenuate flood stages." Further, to demonstrate the feasibility of the recommendations, two small scale projects were suggested for immediate implementation. (State of Tennessee, 1994)

This agreement has been hailed by the environmental community as a huge victory, and they have heaped praise on the Governor for his major part in bringing it about. But, it is also interesting to note that the steering committee and the Governor's office are concerned that the proposed redesign will not meet the Corps traditional approach to benefit-cost estimation. By this, they appear to indicate that the restoration benefits of the project will be ignored or undercounted. It is uncertain whether, and to what degree, they are worried about losing in any cross-Corps comparison against other restoration projects.

Thus, we see here a pattern of early enthusiasm for traditional engineering approaches to hydrologic control; disenchantment as environmental costs become more obvious; and lawsuits that slow and, for periods, stop progress on the works. It seems highly unlikely that this pattern is confined to one small part of one mid-South state.

Such impasses represent political opportunity, and one would expect to see efforts at resolution. The Tennessee example may be unusual in that the Governor put his prestige and power behind the negotiations. But, it may nonetheless suggest a model to be explored—a model that is very similar to that espoused by Shabman and Schkade, except for the locus of the initiative. Finally, the concerns of the steering committee about how the Corps will deal with the proposed resolution suggests just how urgent is the need for well-thought and well- articulated guidance to the field.

If this is an opportunity for the Corps in the coming decades, and if the limits on action are as summarized above, what guidance do the papers collected in this report offer?

PATTERNS FROM THE INVITED PAPERS

It should not be surprising, though it may be just a bit disappointing, that the four papers present something very far from a unified front. Indeed, one might say there are four very different approaches here, or perhaps three and one-half, since there is some agreement between Schkade and Shabman on:

- the fragility and general unreliability of the contingent valuation method of attempting to get benefit estimates for restoration projects; and

- the desirability of developing, systemizing, and using negotiation processes to define values and reach conclusions on project desirability.

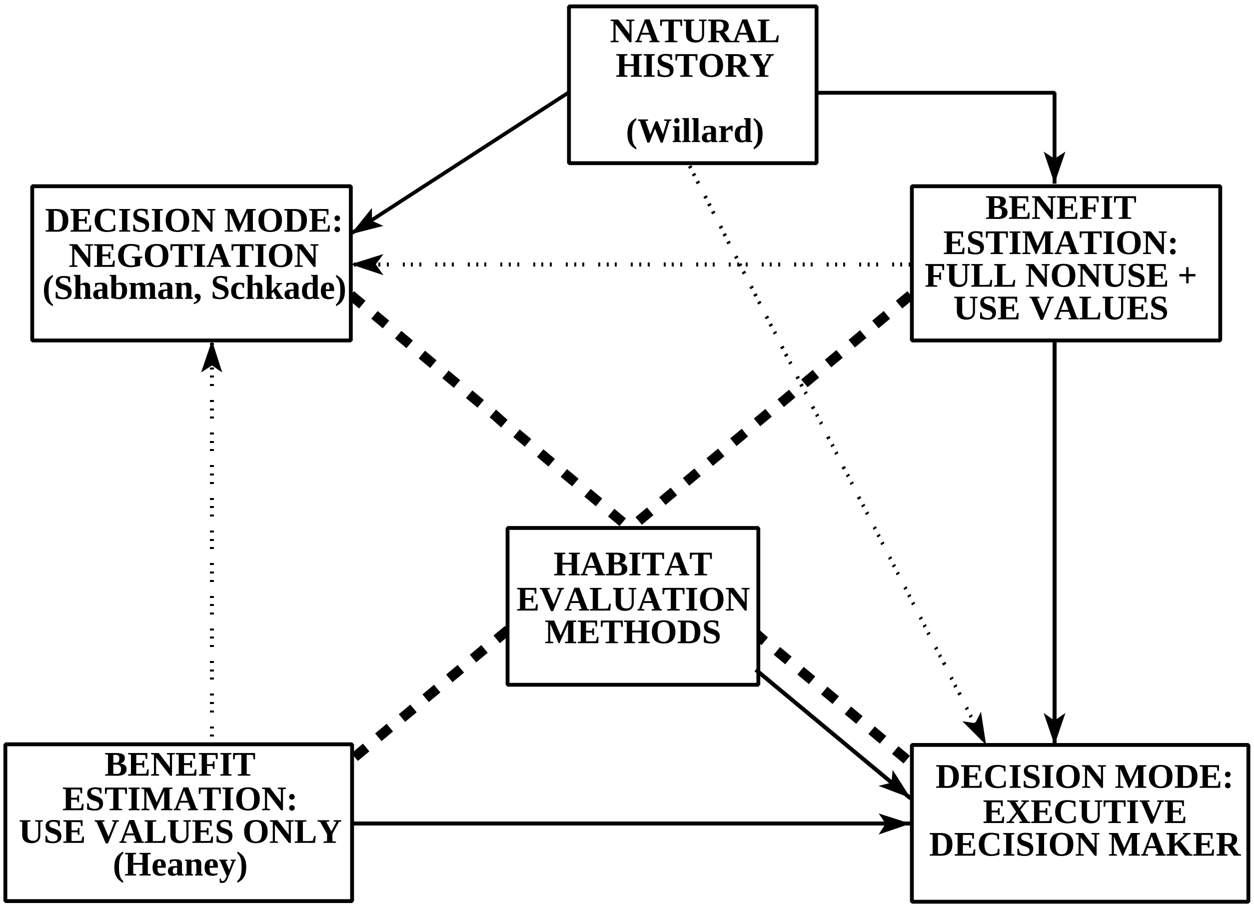

FIGURE II-1
SCHEMATIC OF THE POSITIONS AND RELATIONS OF THE PANELISTS REGARDING ENVIRONMENTAL RESTORATION PROJECTS

Despite the lack of agreement, however, there does appear to be a pattern in the approaches and recommendations. This pattern is visualized in the shape and terms presented in Figure II-1. Here, the basic shape is a rectangle, with the SW/NE diagonal representing the continuum between a concentration entirely on use-based benefits (commodities, recreation, irrigation, flood control, even aesthetics) and an all inclusive benefit notion that includes the so- called nonuse values (option and bequest, and intrinsic or knowledge, for example). Heaney places himself close to the southwest end of this range, while Willard, without discussing benefit estimation *per se*, is clearly close to the northeast end in terms of his view of what is to be valued in an ecological system. The other two authors appear to believe that the values that are "constructed" (Schkade's term) via negotiation will include nonuse categories. But, they are not concerned to dwell on the distinction explicitly.

The other diagonal of the basic box represents a continuum of decision-making modes—between "constructed" valuation via negotiation at one extreme and a classic, executive agency model depending heavily on cost-benefit analysis at the other. Two of the authors, as previously noted, are very much at the negotiation end, though not against informing this process in technical ways. Heaney is definitely at the classic end, with a very positive view of what can be accomplished with sufficient data and ingenuity. Just as clearly, Willard has problems with cost-benefit analysis, but it is not clear how he would suggest the Corps organize data (or people, for that matter) in the interests of reaching a decision. For this reason, outside the "boundary" of the rectangle, another approach has been added that may feed information in a couple of directions. It is termed "natural history," the phrase that Willard would likely apply to the extended data gathering and interpretation activity he describes. Finally, by way of tying in another approach with which the Corps is familiar, cost-effectiveness analysis based on one or another habitat evaluation or measurement systems has added within the rectangle as the source of "effectiveness." It is shown as close to the use-based valuation and the classic decision modes' corner points.

If the diagonals of this schematic represent continua, the explicit lines connecting the approaches are meant to show potential information feeds. Thus, either version of benefits definition can feed into either a cost-benefit or a negotiated value construction and decision mode. For that matter, habitat evaluation/cost effectiveness, and even cost-benefit itself, can be used as information sources for negotiation; though some might object that such feeds would be more distorting than helpful because of the (misleading) implication that they carry a "right" answer. The natural history approach to information organization can also feed information into several of the other processes, though only the potential links to full use/nonuse benefit estimation and the negotiation decision mode is emphasized here.

INFORMATION AND ORGANIZATION ALTERNATIVES

With this schematic notion of relationships in mind, some comments on each of the "boxes" individually should be discussed. For the information generation and organization activities (benefits estimation, habitat evaluation, natural history), this discussion will first center on sources of data, units of observation and aggregation, and positive features and problems of concern, then turn to matters of reproducibility, and so forth. For the decision modes (benefit cost and negotiation, with a word about cost effectiveness), a comparison will be made of the decision modes and the Corps requirements as outlined above.

Benefit Estimation-Use Only

The advantages of adopting a use-only definition of the benefits to be counted are two-fold. First, it is important to explore the controversy about nonuse values, what they mean, and whether they can actually be discovered and secondly, to maintain the possibility of using only the so-called indirect or revealed preference methods of actual estimation (See Cummings and Harrison, 1995, for a recent example). Thus, property value hedonics, recreation travel costing, defensive expenditures, and weakly complementary expenditures, are all in the available tool kit, and all depend on the use of data in markets that reflect environmental quality; not on stated preferences or intentions. Thus, the weaknesses of the contingent valuation method are of no concern.

Heaney sketches a method that he and his colleagues applied to a wetland restoration project in central Florida. The benefit categories for which dollar values were reported include flood control, storm water runoff retention, wastewater treatment, and recreation. The unit of aggregation in this work was the acre. That is, the total benefit from a project restoring A acres of wetland would be, in simplest terms, $A \cdot b$, where b is the estimated total use value per acre. (In the Florida study, there were several separate wetlands that would be restored and each apparently had different per acre benefits, but the principle remains the same.) The per acre numbers themselves come from more or less complicated calculations, some of which are of the alternative cost form (the water quality related benefits), and others of which involve original surveys (recreation).[3] While it is not at all easy to follow the summary of the calculations that lead to the values attributable to wetlands, the principle being illustrated is clear.

Before the Corps decides that this general approach solves its problems—at least on the information generation side—it should, however, consider that while indirect methods do not suffer from the same recognized infirmities as contingent valuation method (CVM), they are rife with their own varieties. First, consider recreation benefits as an example.[4]

- Recreation surveys can be done at the site or at homes. The former is easier; the latter may be better at avoiding bias.

- Recreation benefits that depend on changing availability in nonmarginal ways around an entire region should flow from quite a complex system of interconnected demand equations. These are further complicated if new access points to entirely new (not currently observable) opportunities are contemplated.

- The correct values to use for recreation travel time, and ultimately for recreation days spent at various activities, are not questions susceptible to "scientific" answer.

- Even the functional form for a recreation visitation equation is an essentially arbitrary choice, but one with potential large effects on the estimated benefits.

In addition, hedonics has its own difficulties, including, again, functional form, but involving more fundamental problems of identification (e.g., Bartik, 1987; Cropper *et al*, 1988).

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[3] One of Heaney's strongest recommendations that the acquisition of relevant data be made a higher priority by social scientists generally, and by those with responsibilities that require benefit estimation, specifically. It is also worth observing that since some of the data Heaney reports in the central Florida study comes from other parts of the state (e.g., land values from Lake Okeechobee) he is, in effect, engaging in "benefits transfer" work. Since this general approach is espoused by Shabman, this makes one more instance of agreement across papers—an area exactly on target with respect to data availability problems.

[4] See Vaughan & Russell, 1982, for sensitivity analysis on several of these points.

But, going beyond any single category or technique are two overarching difficulties. Most important, the issue of nonuse benefits is by no means a settled issue, but it can be said that the weight of environmental economics thinking would now appear to agree with the proposition that such benefits are real and should in principle be "counted." (As pointed out below, there seems to be further agreement that there is no appropriate way to estimate nonuse benefits separately from use-inspired benefits.) Focussing exclusively on the NED account in the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies* (P&G) will provide a benefit value for the project, but it biases the results downward. This can be called "conservative," but it is conservatism of the special kind that protects the status quo when the question at issue is environmental restoration.

Second, even within the category of use-inspired benefits, there are potential over and underlaps that make it difficult to be confident we are counting all and only all of what is our aim. For example, boating and fishing are complements. It is very difficult to find data that allows one to get at a "pure" boating benefit. The same can be said when considering property value changes and recreation. One would like to make sure that only nonresident (nonowner) benefits show up in recreation numbers attached to a specific site or project if one is also taking credit for shoreline property value changes. This may or may not be possible.

In short, the use-benefit-only position has some serious appeal because the resulting estimates need never involve stated preferences, only revealed ones. Its appeal is tempered by recognition of the several, essentially arbitrary, choices one must make in applying any one of these methods, and by the under and overlap problems that arise when total benefits are obtained as the sum of separately estimated benefit categories, some of which are defined by use and some by implicit aggregation processes, as in property value hedonics. Further, it seems too early in the continuing debate to abandon the notion of bringing in nonuse benefits.

Including Nonuse Benefits

Not surprisingly, the positive and negative sides of this choice are almost mirror images of the use-only approach. Most important, there is, as yet, no accepted way of getting at nonuse benefits other than via the contingent value (direct questioning) method. As Shabman and Schkade point out forcefully, this leaves the resulting numbers open to methodological objections of a quite fundamental nature. For example, there is strong evidence that respondents to such surveys, while not purposefully misrepresenting their willingness-to-pay, arrive at numbers to give the interviewer by wildly irrelevant and irreproducible methods ("heuristics").

Perhaps, unfortunately, there does not appear to be any way, either, to obtain use-inspired benefits separately from nonuse. In particular, it cannot be hoped to combine the strength of the revealed preference methods with contingent valuation aimed only at nonuse[5].

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[5]For an ultimately unconvincing attempt to add separately estimated non-use to use values, see the study of the value of the undammed Tuolumne River by Rob Stavins for the Environmental Defense Fund, EDF, 1984; for the argument against separable estimation, see Cummings & Harrison, 1994.

Further, the restoration project decision is one of those in which the willingness-to-pay/willingness-to-accept disjunction may be significant. This is because it will be possible to make a case that the original project deprived the affected population of a status quo situation and reduced the natural world service flow. Given this "reference point," the correct question related to restoration benefits should be how much those originally deprived would have been willing to *accept* as compensation for the damage; not how much they would now be willing to pay to get back to the status quo *ante*. But, it is unfortunately widely accepted that we do not yet know how to obtain serious responses to WTA questions[6] (See Knetsch, 1994).

The unit of investigation and of aggregation using the CVM is the individual. But this also raises the questions: Which individuals will have relevant preferences and which should be "counted"? The first question is often referred to as the extent-of-the-market issue. Taking, for example, the Central Florida lakes and wetlands evaluated by Heaney and his colleagues, the first question asks, in effect, how far away one can go before no one is concerned about the proposed restoration? Observe that a similar question should be asked for a recreation benefit estimation but is often not given any thought because participant sampling happens at the site of interest. Further observe that, if we are interested in use plus nonuse benefits, we would expect the extent of the market to be expanded over that for use-only benefits. Finding the extent of the market is not easy, though at least it is, in principle, technically possible. The second question of who should count, on the other hand, is normative and may be seen as political or ethical, depending on taste (See Whittington & MacRae, 1986, for some considerations).

A final, very large obstacle in the way of full benefit estimation for ecological restoration is the difficulty of choosing and conveying relevant (to benefit estimation) information about ecological systems to lay respondents. (This is, in fact, the subject of a multiyear research program just getting underway at Vanderbilt University and Oak Ridge National Laboratories.) Thus, even if one were willing to gather data with CVM, one would be ill-equipped to do so because of the inability to convey to respondents a multidimensional characterization of the difference between the before and after restoration states of the system to be affected. And the lack of knowledge here is quite complete. No one is certain of how many dimensions lay people can handle nor which indicators of system condition are meaningful to lay people and provide a technically accurate notion of system condition. Finally, what is the best approach to convey any chosen information to respondents—what mix of words, numbers, charts, still pictures and even video images produces high response rates and internally consistent answers at least.

Thus, in summary, there is a case for attempting to include nonuse values in benefit estimates where ecological system restoration is at stake. But, there is still considerable controversy about whether and how well CVM, the one method capable of producing estimates reflecting nonuse motivation, taps into internal data and thought processes that deserve to be taken seriously.

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[6] Again, WTP, which would be presumed as lower than WTA, could be called "conservative." But the same objection would apply here as to the argument for the conservatism of use-only benefits.

Habitat Evaluation

A method of dealing with restoration that seems to be widely used in, and familiar to, the Corps is to concentrate on habitat effects—either habitat for a single species or for a wider community of species.[7] Methods such as the Habitat Evaluation Procedure (HEP), the Habitat Evaluation System (HES) and the Wetlands Evaluation Technique (WET) combine many individual measurements from the natural world, by way of more or less common sense translation formulae, into indices of suitability. (For an overview, see Greeley-Polhemus, 1991. On the details of WET see Adamus, et al, 1987. For a bottomland hardwood forest community habitat model, see O'Neil, et al, 1991.) These habitat measurement methods usually are not intended to be valued in dollar terms, but instead are treated as "effectiveness" measures.

It is likely that many participants in, and observers of, restoration planning consider the major strengths of the habitat methods to be that neither people nor money are involved. The measures, thus, have the appearance of "hard" science and do not suffer the moral taint that goes with translation into dollars.

Taken on their own terms—as science—the methods give the impression of being good guides to what might usefully be measured in order to characterize an ecological system's condition. But the formulae used to combine those measurements look quite *ad hoc* and arbitrary, even if based on such familiar notions as logistic functions and symmetric effects around an optimum level. (See Russell, 1992, for a few examples from the bottomland hardwood forest model referred to above.)

Viewed as a substitute for an effort to estimate benefits, the methods suffer both because they implicitly ignore routes to benefit accrual and because they ignore functions of ecological systems that might equally well be taken into account. Because we are not talking dollars here, it is not meaningful to say that it is undercounting. But, it cannot be expected that any broader optimality results would hold for habitat cost-effectiveness choices. That is, there will not be a perfect correlation (perhaps not even a very high one) between any habitat suitability measure and either benefit measure: use, or use plus nonuse.[8]

Notes on Reproducibility, Comparability and Defensibility in the Information Context

All the methods described above have the quality of reproducibility in some measure. For example, the indirect estimation methods behind use-only benefit numbers can be carefully described

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[7] None of the authors of the four papers pushed any habitat method. This author includes the notion because it is important within the Corps currently.

[8] It has been noted by a reviewer of a draft of this paper that none of the habitat models is meant to be an absolute measure of ecological condition. Rather, all are seen as generating "output" change predictions for contemplated actions. Their use in decision-making is confined to guidance, with actual decisions explicitly recognized to depend on other factors such as watershed context and system rarity.

so that, given the original data sets, the benefit estimates themselves can be reproduced by reviewers. This is not the same thing as starting with the raw data and producing benefit numbers by using some other equally defensible functional forms, values for recreationists' time, assumptions about competing opportunities, etc. In general, one would not expect the results of the second experiment to match the results under review.

When nonuse values are brought in and the CVM needed to get at those, the reproducibility is of a different quality. Here, given the survey results; the statistical methods used to produce, for example, willingness-to-pay equations; the characteristics of the sample of respondents; and the population; it should be possible for reviewers to reproduce population benefit totals. But again, this is certainly not the same thing as starting with the problem definition, designing another survey instrument, and so forth. It may not even be possible to reproduce the numbers starting with the same survey instrument but a new respondent sample. That, in effect, is what some of the most damaging criticisms of CVM are saying: responses are not just randomly distributed around a mean that can be "discovered." The individuals' means or true values do not even exist in any useful sense.

Considering the two nonmonetary methods of organizing information, what is being referred to here as the natural history method seems less likely to be reproducible. That is not because any one piece of data is ill-defined or not itself reproducible, but because no protocol seems to exist to guide exactly which pieces will be sought. In addition, the interpretation of any given set of pieces appears to involve rather a big dose of art or at least craftsmanship—a personal model applied to an idiosyncratic data set may overstate the problem but perhaps not by much. On the other hand, if habitat evaluation is to live up to its objective, scientific billing, it must be possible to have two independent "surveyors" arrive at the same index value for the same system.

Comparability refers to the possibility of using results from the method of information organization to compare the desirability of two proposed restoration projects, perhaps involving different systems in different regions. The benefit estimation methods are designed to do exactly this, so no problem on this score should be anticipated (though as pointed out, some will not believe either number). Natural history, in contrast, could not be expected to allow such comparisons in general. Perhaps if only one observer/rater were involved in each place (or perhaps one team), that entity could produce comparisons by some internal decision process. Habitat evaluations will be comparable as long as the same systems (measurements, formulae, etc.) are used everywhere. It seems more likely, however, based on a close reading of these methods, that there will be different index approaches appropriate to different project systems—wet vs. dry; fresh vs. brackish; high altitude vs. low; high rainfall vs. low; and so on. It may be that a truly generalized system is even now being developed for exactly the purpose of maintaining comparability. In its absence there will be gaps. Cost-effectiveness comparisons will only be meaningful where there is a common effectiveness metric.

External defensibility may be thought of as a test of a method's ability to appeal to observers and would-be critics outside the professional domain that produced it. But, there are several dimensions on which the appeal may be made and more than one audience to consider. For example, economists would be inclined to argue that benefit estimation methods consistent with the fundamental tenets of microtheory are defensible. But external audiences as disparate as hard-core environmentalists and professionals in risk analysis may not agree. The former may well object to the notion of holding nature against the yardstick of money; the latter may point out the accumulating evidence that the assumptions at the root of microeconomics do not appear to relate very well to the real human condition. Habitat evaluation, on the other hand, may be more defensible in the abstract than in practice. The notion of an objective, scalar measure of restoration output—one that does not involve dollars—may have great appeal to both the environmental community and to decision makers. But closer examination of the measurements made, their conversion into normalized arguments, and their final combination into an index may lead to perplexity. "Why that step function? What if this was used instead of that averaging approach?" are the sorts of questions that may arise and signal problems for defensibility. Analogous questions, though perhaps not so narrowly focused, may be expected when the natural history approach is exposed to outside review.

DECISION PROCESSES

There are two major contending decision processes reflected in this collection of papers. One might be called a classic executive agency model, in which cost-benefit analysis counts for a great deal, though not for everything. The concession to political realities takes the form of a concern with predicting the distribution of costs and benefits as a way of anticipating and perhaps developing project modifications to address sources of opposition to contemplated projects. But, there is at the heart of this vision a "decision-maker," who has the power to choose among alternatives and whose objective function is a somewhat modified version of economic efficiency. The second process is usually referred in the papers as "negotiation," and the vision implicitly or explicitly sketched involves gathering the local (and perhaps not so local) "stakeholders" or their representatives, providing the resulting group with information as requested and perhaps with mediation help, and waiting for a consensus project to emerge.[9]

A few general observations may be useful to provide a bit of perspective before going into the matters of reproducibility and so forth. Consider first the executive-agency/decision-maker model. Depending on whether one sees the glass as half empty or as half full, one might say either that this version of public decision-making was always the unrealistic (even dangerous) model of what traditional economists wanted to see happening; or that this is the essence of our regulatory system, though the role of benefit-cost analysis was always overstated. Certainly efficiency, in the economists' sense, never drove the system, though it was often necessary to bow in that direction as part of the process. Witness the claims of "cooked" cost-benefit analyses for water projects and, much more recently, the executive orders of Presidents as dissimilar as Reagan and Clinton requiring cost-benefit analysis in various decision settings. Equally certain, no single executive agency decision-maker could, outside of national emergencies, make decisions that affect members of the public without conducting some sort of political base-touching exercise. This seems to be true even for the independent "commissions" for which terms are meant to run across presidential elections. It is obviously true for the EPA Administrator and is becoming more obviously the case for the Corps itself.

Thus, seen in one light, the recent increase in popularity of the negotiation mode of public decision making looks to be simply a formalization and extension of what was happening informally

[9] As already noted, the results of cost-benefit analyses might be part of the information provided to the group seeking consensus.

and unevenly. One way of explaining the perceived need for formalization and extension is to observe the growing power of affected parties—even indirectly affected parties—to throw the proverbial spanner in the works after the agency decision process had ostensibly concluded. Put almost crudely, an appealing notion would be: If they can stop us from doing what is decided best after it is decided, why not try to get them to buy into the process before hand and, at least, possibly obtain a decision to do something that will not be challenged. A related observation is that no organ of "normal" government is structured to provide the special sorts of coverage and representation that seems to be needed in special decision situations such as those that arise in the restoration context. Advocates of this approach can point to some successes: examples include negotiated EPA regulations ("Reg Neg") (Lyons, 1991) and the so-called Keystone Group consensus document on management of DOE's environmental restoration program (Federal Facilities Environmental Restoration Dialogue Committee, 1993).

Seen in another light, that of traditional procedural legitimacy, the negotiation model, as it seems to play out in practice, represents quite a break with the past, at least on two dimensions: representation and the ultimate decision rule. Representation is *ad hoc*. There are no geographic districts sharply drawn, but rather the intention is to have categories of interest represented. The choice of actual representatives is not by vote of the putative interest groups but something closer to the way a National Academy committee is put together—through networking, persuasion, and balancing efforts conducted by the agency or a contractor. Decisions by the new collective of "representatives" are clearly most useful if made by consensus (unanimity). Otherwise, the purpose of avoiding *ex post* challenges may not even be served. This sort of decision rule effectively formalizes the veto of every person (interest) in the group. It favors the status quo over changes; and it appears to lead to sharing rules that on the surface at least, treat every interest equally.[10] These are attributes one might expect to see, given the origin of the underlying challenges to agency decisions in mistrust of agency motives and methods.

The dimensions of reproducibility, comparability, and defensibility apply somewhat differently to decision processes than to information organization. First, reproducibility is the essence of the classic cost-benefit basis for a decision. Only if the accounting stance (for cost and benefit definition) is allowed to differ at different levels in the organization, or if the political base-touching extends down to lower levels, will it be a problem for higher levels to reproduce decisions. One might even speculate that it is exactly this quality that appeals so much to an agency in which initiatives tend to arise from the field rather than from legislative mandate or Presidential campaign promises. Decisions of a local or regional negotiating process are not reproducible in any sense except that by reading the documentation a reviewer might be brought to agree with them.

Similar statements apply to comparability. Unless there has been an error in guidance, a cost-benefit analysis from California will be comparable to one from Florida, even if totally different projects are involved. This is a strong advantage for budgetmaking, whatever its drawbacks. But there is no way to compare (judge between) decisions from different local consensus groups in building a budget.

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[10] Thus, the Keystone Group called on DOE to share budget changes equally across the sites requiring restoration--in proportion to the base-year budget share of each site—so that budget shares would not change over time. This was an explicit rejection of priority setting on the basis of assessed health risk differences across the sites.

Finally, defensibility is obviously dependent on the audience addressed. If the above sketch of the background for negotiation is at all accurate, it suggests that the popularity of that method arises because the executive agency model, at least in some settings, proved indefensible. That is, attacks by interested parties were more frequent and more permanently successful. On the other hand, in the context of tight national budget constraints, it may be hard to convince national agency executives and national legislators that a process explicitly ignoring information that helps in priority setting is really helpful. This does raise an interesting question: Might it be possible to have a national consensus group analogous to the DOD Base-Closing Commission that would operate in the environmental restoration area? Input to the group could include both the results of local negotiations and analyses with an explicitly national stance, including benefits and costs as well as budget implications.[11]

SUMMARY

It seems tenable that the several different points of view and approaches evident in this collection of papers do not survive simply because single disciplines cannot themselves develop a lock on the truth (though that is true), nor because any of the disciplines is committed to something clearly inappropriate. Rather, the disagreements reflect an inconvenient but unavoidable element of reality: *There is no clearly dominant approach*. In organizing information about results we may only buy reproducibility, via narrow result definitions, at a cost in defensibility and comparability; or comparability, through full-scale benefit estimation, at a cost in reproducibility and defensibility. Similarly, in choosing an approach to decision making, the executive agency model guarantees reproducibility and comparability as decisions are reviewed at higher levels. But that model has become increasingly difficult to defend since it does not include "stakeholder" concurrence. On the other hand, local consensus negotiations may be defensible—especially as politically necessary in the new world of public decision. But, they are not, in general, reproducible in any meaningful sense, nor do they allow for comparing one local decision with another from a different region or another involving a different type of investment. In short, the Corps has some freedom to maneuver but no solution will solve all its problems.

[11] Another function of such a group could be the establishment of resource priorities for the guidance of Corps field personnel.

III. ENVIRONMENTAL EVALUATION IN FEDERAL RESOURCE AGENCIES

INTRODUCTION

The previous chapter presented the diverse perspectives of the panelists and discussed some of the theoretical and practical issues surrounding the different approaches to monetary valuation and nonmonetary evaluation of environmental investments. This chapter describes how other Federal agencies are responding to emerging environmental imperatives and these practical and theoretical challenges by changing their missions, operations, and research agendas. These responses in the contexts of diverse political and organizational contexts suggest that the prospects for monetary valuation and nonmonetary evaluation measures in Federal decision making are potentially quite different.

In response to continuing pressures for environmental protection, mitigation, and restoration, Federal resource management and regulatory agencies are undergoing profound evolutions. Their missions, operations, and cultures are changing, but the rates and characters of the changes in the different organizations are far from uniform. A wide range of responses to the pressures for environmental planning reform is not unexpected given the diverse organizational characters and decision-making contexts.

Monetary valuation and nonmonetary evaluation techniques for environmental resources are two dimensions of this complex evolutionary process. In many ways these evaluation techniques exemplify the prospects and challenges of the transformations of these agencies. The development of rational, defensible, and replicable environmental evaluation techniques could significantly improve Federal environmental decision making. They could be very effective in the pursuit of: (1) efficient resource allocations; (2) equitable balances of competing interests; and (3) reductions of environmental conflicts. However, there are formidable impediments to the widespread incorporation of these techniques into Federal decision-making processes. Among these obstacles are the gaps between theory and practice and between case-specific applications and standardized procedures.

The following is an overview of the status of research and practice of environmental evaluation techniques by other Federal agencies. It is intended to identify the state of the art techniques, models, and data in Federal environmental evaluation. In addition, applicable Federal research programs will be identified. This effort will focus on opportunities for and limitations of using existing models and data in Federal environmental investment decisions.

Monetary valuation and nonmonetary evaluation in Federal agencies are discussed in the following sequence. First, to identify their particular decision-making contexts, the broad changes within Federal resource agencies toward more environmental activism are discussed. In particular, the trends in the Federal government toward more holistic resource management strategies are explored. Second, the environmental evaluation research programs and practical applications of the

Federal resource agencies are profiled. Finally, alternative monetary valuation and nonmonetary evaluation techniques are discussed.

ORGANIZATIONS IN TRANSITION

The missions, organizations, and cultures of the Federal resource agencies are rapidly developing more environmental orientations. These changes will probably not dislodge these agencies from the southeast corner of the decision-making framework in Figure II-1 (i.e., the executive agency model), but they are significant nonetheless. The forces behind these changes are the adverse environmental impacts of traditional resource management and the opportunities associated with environmental restoration and protection. As the Federal resource agencies become more involved in environmental activities, the organizational changes may create opportunities for nonmonetary evaluation techniques and could limit, at least in the near term, the potential of monetary valuation techniques.

Redefined Agency Missions

The changes within the Federal resource agencies have been structural and cultural. Some agencies have redefined their missions and reorganized their structures in accordance with new environmental service portfolios. Others have experienced cultural changes within the organizations that raise the priority of environmental resources within traditional agency activities.

Virtually all of the Federal resource agencies have been changed by external environmental pressures, whether through public involvement activities, interagency cooperation, or legislative and executive mandates. Resource management agencies with conservation responsibilities such as the U.S. Fish and Wildlife Service (USFWS) and regulatory organizations with environmental mandates such as the Environmental Protection Agency (EPA) continue to wield significant authority over economic and environmental affairs in our society. In the cases of the Spotted Owl and Pacific Northwest Salmon, USFWS has the potential to impact regional economies and land uses through its interpretation of the Endangered Species Act. Other Federal organizations with economic development traditions, such as the Corps, the Bureau of Reclamation, and the Forest Service, are redefining themselves to address new environmental priorities. As a consequence of these changes, the agencies have the potential to forge new relationships with organizations and interest groups that were historically distant.

As illustrated in Figure III-1, the different types of resource agencies have similar environmental challenges and opportunities. These include combinations of environmental activities within traditional agency missions and new environmental opportunities. Environmental mitigation activities exemplify the former, and environmental restoration represents the latter. There is some overlap between these two extremes, as new environmental opportunities can be pursued within traditional agency missions.

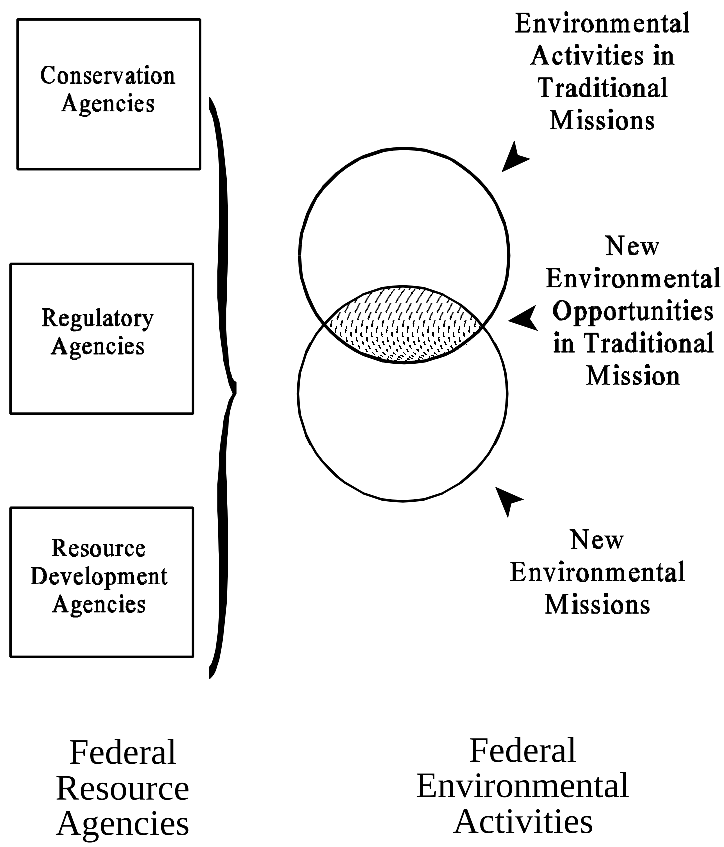

FIGURE III-1
FEDERAL RESOURCE AGENCIES AND ENVIRONMENTAL ACTIVITIES

The Bureau of Reclamation provides a dramatic illustration of this process of agency transformation. The Bureau recognizes that traditional water development is very unlikely in the future (Bureau of Reclamation, 1990). Since 1987 it has been reorganizing to reflect a new environmental orientation (Farmer, 1988). The new mission statement developed as part of the Bureau's Strategic Plan (1992) reflects this agency's new environmental tilt: "To manage, develop, and protect water and related resources in an economically and environmentally sound manner in the interest of the American public"(EPA, 1993). The Bureau's Strategic Plan has been divided into five major categories, which demonstrate the diversification of the Bureau's traditional water development mission to include additional environmental protection and management activities:

- Managing and developing resources
- Protecting the environment
- Safeguarding the public's investment

- Building partnerships

- Fostering quality management

The Bureau of Land Management (BLM) is another agency in transition (BLM, 1994). As directed by the Federal Land Policy and Management Act, the BLM is committed to managing resources under its purview with full recognition of their multiple uses and with the goal of sustainable development. It is actively moving to an ecosystem-based management approach that considers the interconnected values and uses within an ecosystem.

The changing missions and structures of the Federal resource agencies should stimulate progressive research in environmental decision making. However, the relationships between Federal environmental activity and interest in monetary valuation and nonmonetary evaluation techniques are complex. The implications for the various evaluation measures will depend on the balance between conditions that promote and constrain their research and application.

New Management Parameters

The environmental restructuring of Federal agencies has been accompanied by more subtle changes in their operations and cultures. As part of this change, the new environmental priorities require incorporation of the following new parameters into decision making, which will have different implications for monetary valuation and nonmonetary evaluation techniques. As indicated in Figure I-1, the nonmonetary evaluation techniques, many of which measure changes in ecosystem outputs must account for these factors in their ecological habitat assessments, but monetary valuation techniques must go a step further and account for these parameters in dollar-value terms.

Functional Values

Federal perspectives on the functional value of resources are changing from viewing resources as separable, extractable economic materials (i.e., inputs) to considering them as inseparable components of ecosystems. Ecological research has penetrated resource management to the point that the integration of biogeophysical systems is not questioned even if the details of their complex interconnections are not fully understood.

Temporal and Spatial Scales

The values of resources are now recognized as exceeding their immediate practical usage. The temporal scales of Federal resource management have been evolving as time horizons of decision making have been extended beyond their historic boundaries. The concepts of sustainability and reversibility have become commonplace in the public and agency lexicons.

Spatial scales of resource management have undergone a similar transformation as linkages between local, regional, and global scales are increasingly evident. The spatial linkages are two-way, allowing local manifestation of global changes and global aggregation of local changes.

Nonuse Values

The most significant decision parameter for monetary valuation of environmental resources may be the need to consider nonuse values in addition to use values. In contrast to other evaluation techniques, monetary techniques often require inclusion of nonuse calculations for input into benefit-cost analyses.

HOLISTIC RESOURCE MANAGEMENT

Currently, there is a trend of Federal agencies toward more holistic resource management. This is stimulating research and application of nonmonetary evaluation techniques for environmental resources. However, it also holds considerable promise for monetary valuation techniques as well, although this optimism may require many years to be validated.

Two elements of this trend are particularly powerful forces of change in Federal environmental management: ecosystem and watershed management strategies. Ecosystem management attempts to fully recognize the web of interconnections between the components of an ecosystem. Watershed management has a similar holistic view, but it delineates environmental management activities on the basis of watershed boundaries. There is widespread support among Federal resource agencies for both of these strategies, and practical applications of these concepts are being aggressively pursued. Ecosystem management has fewer obstacles for implementation, since it can be applied on a variety of spatial scales. Watershed management strategies typically aggregate toward larger scales, for example large river basins forming "bioregions". Larger scales may make watershed management more difficult to implement than ecosystem management. The larger number of institutional jurisdictions increase the potential for political conflict.

Ecosystem management by the Federal resource agencies has had support in the Clinton Administration and Congress (House Committee on Natural Resources, 1994). Individual Federal resource agencies have been researching or implementing ecosystem management policies. This includes the EPA, BLM, USFWS, U.S. Forest Service, and National Park Service. To develop a national strategy for Federal ecosystem management, the Clinton Administration has formed an Ecosystem Management Task Force. Among the issues involved in interagency coordination of ecosystem management are appropriate levels of: (1) broad-based research and field testing of ecosystem management principles; (2) coordination between Federal agencies, state governments, local interests, and Native Americans; and, (3) data collection. The issues of data collection are particularly challenging. Ecosystem management techniques typically require data about ecosystem structures, components, functions, and processes, as well as socio economic data regarding human influences on ecosystems. Current ecosystem data are often not comparable between agencies and contain large data gaps. Other challenges to ecosystem management include questions about the boundaries of ecosystems, desired future ecosystem conditions, and ecosystem maintenance and restoration goals.

Habitat assessment techniques have great potential for application in conjunction with watershed and ecosystem management strategies. These techniques could be used to identify the outputs and prioritize the components of ecosystems. These are necessary preludes to effective management of environmental resources with full consideration of ecosystem functions and temporal and spatial interconnections.

At present, watershed and ecosystem management strategies are more focused on nonmonetary evaluation techniques, such as habitat assessment. However, their future promise for monetary valuation lies in the combination of: (1) the increasing quantification of environmental functions of ecosystems and their components; and, (2) the likelihood that monetary valuation would be the next step in the progression of an increasingly technical management process.

Although the environmental activities and orientations of Federal agencies are increasing, the consequent need to explicitly account for new decision parameters has not yet translated into significant allocations of resources to develop and apply monetary valuation measures. For monetary valuation techniques, the complex issues and uncertainties raised by increased environmental orientations generate more questions than answers. For the Federal resource agencies, these additional questions could also threaten unintended negative spillovers if similar questions are applied to the traditional agency activities. The result is that while most Federal agencies currently manage resources with some consideration of functional values of environmental resources, temporal and spatial interconnections, and nonuse values, most do not utilize monetary valuation techniques.

AGENCY RESEARCH AND PRACTICE

There are many ongoing activities in the Federal resource agencies that illustrate the increasing scopes of their environmental programs. Some of these activities have direct implications for monetary valuation and nonmonetary evaluation techniques for environmental resources. Others are less directly relevant to evaluation techniques, but they are suggestive of broad-based increases in environmental activities. In the following discussions of Federal agency research and application of environmental evaluation methodologies, selected agencies will be highlighted as representative of regulatory, conservation, and resource development portfolios.

Environmental Protection Agency

The EPA is the foremost example of a Federal resource agency with a primarily regulatory portfolio. This organization has expressed its commitment to watershed management (EPA, 1993). As outlined below, the EPA has also initiated research on ecosystem and watershed management strategies. In addition, this agency has initiated research into monetary valuation methodologies. One of the most progressive programs within the EPA with respect to environmental evaluation techniques is the Integrated Ecosystem Protection Research Program.

Integrated Ecosystem Protection Research Program

This program illustrates the EPA's interest in holistic management strategies and the need for greater sophistication of environmental management. The goal of this program is to develop the scientific understanding and practical techniques required for effective, integrated ecological risk assessment and ecosystem protection. Flexibility of application is a key objective, and the ability to apply the techniques at a variety of scales is critical. The focus of the program is to reduce uncertainty in ecological risk assessment at the watershed, regional, and national scales by:

- Monitoring current and changing conditions of ecosystems;
- Understanding the structure and functions of ecosystems;
- Modeling ecosystems to predict their responses to perturbations; and
- Assessing the ecological consequences of management actions.

There are three research efforts within the Integrated Ecosystem Protection Research Program. Together, these efforts will generate an integrated framework for ecosystem analysis based on risk assessment that can operate at multiple scales.

Integrated Watershed Protection and Restoration Research. The emphasis of the integrated watershed protection and restoration research is on including risk assessment in watershed management. The objectives of this research program are to:

- Define user needs for risk assessment of watershed protection;
- Identify the most uncertain elements;
- Improve predictive capabilities of watershed management; and
- Develop techniques for defining and assessing risk management options.

Integrated Regional Ecosystem Protection and Restoration Research. While the first research program focused on watershed management, this research concentrates on ecosystem management. The objectives of this program are to:

- Detect ecological change and its causes;
- Define realistic environmental goals;

- Evaluate consequences of management options;
- Design multiple-use management programs;
- Target geographic areas for protection and restoration; and
- Evaluate effectiveness of management actions.

Integrated National Monitoring, Assessment, and Criteria Research. The above watershed and ecosystem management research is only relevant if there is a sufficient baseline of scientific knowledge about ecosystems. To identify and collect critical data needed for informed management, the objectives of this research program are:

- Formulate monitoring and assessment techniques and methods;
- Develop a national monitoring and assessment framework;
- Conduct assessments;
- Monitor effectiveness of ecosystem management; and
- Transfer information between different agencies and government levels.

Chesapeake Bay Estuary Program

This interagency program is under the auspices of the EPA. It is intended to protect and restore the Chesapeake Bay Estuary, but to do this requires research into the ecological and economic systems of the bay and its watershed. The program specifically is attempting to integrate economic and ecological modeling and analysis to increase the understanding of human impacts on watersheds and aquatic ecosystems. It is closely examining land use, land development patterns, and agriculture in the watershed. Although this research program is focused on the Chesapeake Bay, it has marked similarities with the EEIRP. In addition, it is facing many of the evaluation challenges identified in Chapter II and the invited papers.

As part of this program, the EPA has initiated an environmental evaluation research program. Within a focused research element entitled Ecological Economic Modeling and Valuation of Ecosystems, the EPA is attempting to better understand:

- How ecosystems function;
- How they are effected by human activity;
- What services ecosystems provide to society; and

- How those values can be measured.

As part of this research element, the EPA has developed a "spatially articulated" ecosystem model of the Patuxtant River basin in Maryland. Using this general ecosystem model, economists and ecologists are dividing 1,000 square miles into 90 plots. The model will represent each plot as a single ecosystem type (e.g., forest, agriculture, or residential development). Each plot interacts with adjacent plots. The focus is on agriculture, and the emphasis is how new Best Management Practices can increase the value of land and water in the ecosystem.

National Advisory Committee for Environmental Policy and Technology

This EPA advisory committee has recently established three new subcommittees to assist in developing its national policy guidance:

- Data and assessment;
- Implementation Tools; and
- Sustainable Economics.

The Sustainable Economics sub-committee is tasked with evaluating what options exist to reflect the true value of natural resources and the true costs and benefits of environmental protection. Its formation reflects the EPA's recognition of the need to develop measurement tools for environmental benefits that can integrate environmental protection, economic development, and ecosystem management objectives.

Handbook of Coastal Resource Evaluation Techniques

One EPA activity that is particularly promising with respect to monetary valuation and nonmonetary evaluation is being conducted through the National Estuary Program. The EPA is developing a handbook for state and local coastal resource managers and community action groups to investigate pollution sources and their impacts on estuaries (Slaughter, Personal Communication). The focus of the handbook will be on water quality and the value of coastal environments. The handbook will evaluate the alternative methodologies for determination of the value of estuary functions and services and will contain case studies. Of particular interest with respect to monetary valuation methodologies will be the case study of the application of the contingent value method to coastal resources in the Houston-Galveston area.

U.S. Fish and Wildlife Service

Of the Federal resource agencies, USFWS is one of the foremost representatives of those having conservation missions. This agency has expressed its commitment to watershed and ecosystem management (Spear et al., 1993). The USFWS has also initiated a multifaceted program in wetland evaluation. It has established a Wetland Values Bibliographic Data Base of nearly 5,000 articles organized into 13 information fields. (For more information on this data base, contact the Service at 813-570-5412). In addition, the Habitat Evaluation Procedures (HEP) models, developed by USFWS, have been instrumental in the development of nonmonetary environmental evaluation. These models are discussed below. This agency's participation with these models will no doubt continue with additional contributions to nonmonetary evaluation of environmental resources forthcoming (Schroeder, 1993).

One of the most relevant of the USFWS responsibilities for evaluation of environmental resources is the Endangered Species Act. The Act illustrates public policy recognition of the value of the preservation of biodiversity. USFWS interprets changes in ecosystem outputs (i.e., reductions in species population) via nonmonetary evaluation techniques and places species on threatened or endangered classification lists. This Act has often been criticized as reactive and too removed from other Federal environmental management programs. With the reauthorization pending in 1995, the future of this Act is uncertain. However, USFWS has expressed that many of the problems of the act as currently designed could be alleviated with integration of its goals into watershed and ecosystem management strategies. These strategies would be conducive to determination of cumulative impacts by increasing the scale of analysis to overview piecemeal deteriorations in environmental quality.

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA) provides another example of a Federal agency with conservation responsibilities, in this case with marine and coastal resources. NOAA is currently conducting two series of workshops on monetary valuation and nonmonetary evaluation (Weiher, Personal Communication). One series entails regional training workshops which are intended to familiarize state and local coastal resource managers with the fundamentals of welfare economics, nonmarket benefit analyses (e.g. recreation), and concepts of nonuse valuation. These workshops have been initiated in response to significant state and local interest in assessing their coastal management programs. Approximately six of these workshops have been held since the program began in May 1993. This program is expected to last through the summer of 1996. It is expected that a training manual for coastal managers will be produced for this effort by May 1995.

The second series of workshops are more research-oriented. They are intended to foster interdisciplinary communication on the subject of environmental evaluation between economists and ecologists involved in coastal resource management. There has been one workshop to date, and a second is scheduled for May 1995. NOAA's research into monetary valuation methodologies will be detailed later in this chapter.

U.S. Forest Service

The U.S. Forest Service (USFS) provides an example of a Federal resource development agency. This agency has begun to explore ecosystem management strategies and is developing an environmental evaluation research program (USFS, 1993). In June 1994 the USFS sponsored a National Research Assessment Workshop on Fish and Wildlife Valuation. The purpose of the workshop was to assemble ecologists, economists, and representatives of other disciplines to identify potential new dimensions of USFS research on fish and wildlife valuation. The objective was for representatives of the USFS research community, the National Forest system, other agencies, academia, Native Americans, and environmental groups to identify new research questions and priorities. The products of the workshop were assessments of research needs.

The workshops were preceded by a series of national focus groups held around the country. Through a coordinated effort with the American Fisheries Society and the American Sportfishing Association, the USFS identified the need to examine the socioeconomics of fisheries. This, in turn, stimulated formulation of the "Strategy for the 90s", a USFS research program which targets more emphasis on the human dimensions of environmental management.

Additional impetus to the transformation of the USFS comes from its Renewable Resources Economics Program. This program recognizes the need to account for a greater array of forest environmental values and identified research priorities in environmental evaluation within USFS. Other research efforts in which USFS participated have recommended efforts to integrate ecological and economic approaches to achieving sustainable resource development. The Ecological Society of America's "Sustainable Biosphere Initiative" was one such collaborative effort. This effort explored the multiple use goals of ecosystem management and its integrated use of ecological knowledge at a variety of scales to produce the desired resource values, services, and products.

Bureau of Reclamation

As described above, the Bureau of Reclamation (BuRec), like the USFS, has traditionally been involved in resource development activities, in this case water resources. BuRec has an ongoing study of the water resources of the American River in California. Within this study, there is a particular focus on the social valuation of this waterway and alternative plans for its management. The alternative perspectives and values of the various stakeholders will be of particular emphasis.

BuRec has a similar environmental evaluation research program that is associated with the drainage program in the San Joaquin Valley in California. The social dimensions of the problems of selenium drainage from the valley's agricultural lands into environmentally sensitive waterways were a particular focus of this effort. The social impacts of alternative remedial plans have been evaluated in the context of protecting important environmental resources.

Department of Energy

The Department of Energy (DOE) also has some resource development activities. DOE has sponsored research into "nonglamorous" natural resources in the state of Washington (Scott, Personal Communication). The project initially focused on wetlands in western Washington that were nonglamorous in the sense that there was little public recognition of their functions or values to society (e.g. flood control, water quality, etc.). The lack of public recognition would render these resources invaluable in survey-based valuation techniques. The project team attempted to use human analogs of wetland functions, for example the cost of water treatment systems, for evaluating wetland water quality functions. However, the project was constrained by the lack of ecological data regarding the functions of these wetland areas. This case study was abandoned, and a new study area was selected.

The sage steppe of eastern Washington was chosen as the new case study, specifically the relatively undisturbed steppe of the Arid Lands Ecology Reserve on the edge of the Hanford nuclear reservation. The selection was spurred by the extensive ecological data available for this area and the fact that these arid lands can also be considered nonglamorous resources. The focus of this second case study was on the function and values of these lands in their undisturbed state. In particular, the lack of disturbance stabilized the soil with a consequent reduction in the frequency and severity of dust storms in the area. This reduction has distinct benefits to society through decreased cleaning costs, traffic hazards, and health effects. The conclusion was that the value of these arid lands in their undisturbed state is comparable to their value for agricultural or range purposes.

In addition to the above research, DOE's Oak Ridge National Laboratory, in conjunction with the EPA, sponsored a workshop in 1994 on the use of the contingent value method (CVM) to measure nonmarket resources. The workshop was intended to develop a prioritized research agenda for further development of CVM for application to nonmarket environmental goods and services.

NONMONETARY EVALUATION TECHNIQUES IN FEDERAL AGENCIES

Although monetary valuation and nonmonetary evaluation techniques are often interconnected (see Figure I-1), separate treatments of these two categories will be required for the discussion of Federal environmental evaluation research and applications, since the different organizational contexts produce very different evaluation needs and prospects. Nonmonetary valuation techniques will be discussed first.

Nonmonetary evaluation methodologies in the various forms of habitat assessment have become active areas of research and practice. This can be attributed to the holistic resource management strategies that Federal agencies are beginning to adopt and the increasing sophistication of ecological analyses. As a result of these evolutionary processes within the Federal resource agencies, the status and prospects of monetary evaluation and nonmonetary evaluation techniques are quite different.

As indicated in Figure I-1, nonmonetary evaluations often attempt to measure in ecological terms the impacts of environmental projects. Such projects may be mitigation of adverse environmental impacts from an economic development activity or the restoration of deteriorating ecosystems. The outputs of nonmonetary evaluations are typically in terms of the functions or materials of the ecosystem. Nonmonetary evaluation techniques are often used in conjunction with cost-effectiveness analysis. This decision framework will be outlined below and followed by discussion of alternative nonmonetary evaluation techniques.

Ecological Models and Evaluation Procedures

There are many varieties of ecological models. These models target different ecosystems and operate at different scales. Among the different types of models are habitat models (O'Neil, 1991), species population models (Fisher et al, 1991), energy or material flow models (O'Neil et al., 1992), and models based on individual species (Huston et al., 1988). As discussed below, the habitat models have provided the foundation for nonmonetary evaluation methodologies. The other types of models have also contributed to the development of these methodologies through their simulation of the complex interconnections between the different ecosystem components. However, these other models have limited utility in evaluation of environmental resources. They are generally too ecosystem-specific for broad applications, and the outputs are typically biological responses to perturbations rather than some form of environmental evaluation.

Habitat Evaluation Procedures

Table III-1 illustrates a range of nonmonetary evaluation methodologies currently in use. The most popular nonmonetary evaluation technique for environmental resources is the Habitat Evaluation Procedure (HEP) developed by the USFWS (1980). Several versions of HEP have been developed by USFWS. Other agencies and organizations have adapted HEP for their specific needs. HEP was designed with full recognition that the basic methodology would be modified for specific applications and differing funding allocations. Even those methodologies not directly descended from HEP have been influenced by its development and application.

HEP is widely accepted for evaluation of with- and without-project conditions. However, the modified versions of HEP do not necessarily have the same level of acceptance as the original. In particular, the streamlined versions of HEP have received some criticisms that the modifications reduced the accuracy of the models (The Greeley-Polhemus Group, 1991). This should be expected in an evolutionary process such as the development of nonmonetary environmental evaluation.

HEP and its variants utilize essentially the same process. They combine habitat quality and quantity into habitat unit (HUs):

Measurement of quality (HSI) x Measurement of quantity (acres) = Habitat Units

TABLE III-1
EXAMPLES OF ALTERNATIVE ECOLOGICAL ASSESSMENT MODELS

Name	Acronym	Applications
Habitat Evaluation Procedures	HEP	Nationwide; Terrestrial and wetland ecosystems; Output in habitat units per target species
Habitat Management Evaluation Model	HMEM	Nationwide; HEP-based management evaluation model for mitigation projects
Pennsylvania-Modified HEP	PAMHEP	Pennsylvania; terrestrial, wetland, and aquatic ecosystems
Habitat Evaluation System	HES	Lower Mississippi River Valley; HEP variant; Hardwood bottomlands
Wetlands Evaluation Techniques	WET	Nationwide; HEP variant; Wetlands evaluation and ranking
Wetlands Value Assessment	WVA	Louisiana; HEP variant; Coastal wetlands evaluation and ranking
Wildlife Habitat Appraisal Guide	WHAG	Missouri; HEP variant
Habitat Assessment Techniques	HAT	Nationwide; Emphasis on bird habitat
Synoptic Approach to Wetland Cumulative Effects	SAW	Nationwide; Rapid assessment of landscape; Designation scoping process analysis for more detailed research
Connecticut/New Hampshire	C/NHM	New England; Freshwater wetlands evaluation/ranking method
Hollands-Magee Method	H-MM	New England; Freshwater wetlands; Evaluation and ranking
Ontario Method	OM	Ontario; Wetlands evaluation and ranking
Bottomland Hardwood	BLH	Southeast U.S.; HEP variant; Bottomland community habitat hardwood ecosystems
Wildlife Habitat Appraisal	WHAP	Texas; Evaluation of impacts from water resources development on wildlife populations
Tidal Wetlands Evaluation	TWE	Nationwide; Tidal wetlands; Emphasis on structure of wetlands

The acre is the standard measure of quantity, and quality is measured by a unitless Habitat Suitability Index (HSI) from 0 (no habitat value) to 1(optimum habitat value), or in some HEP variants from 0 to 100. HUs are generated by HEP over time, and they can vary from year to year over the lifetime of a project. Therefore, average annual habitat units (AAHUs) are calculated to estimate the habitat value over the life of an environmental project.

Current versions of HEP (e.g., HEP-80) are species-based. They use a selected species as an indicator of habitat quality. A carefully selected indicator species is considered representative of other species in the habitat. A model is used to generate the HSI based on critical physical, chemical, and biological variables. The output of HEP is HUs for the indicator species (e.g., downy woodpecker HUs). Earlier versions of HEP, such as HEP-76, were habitat-based and generated results in the form of acres of bottomland forest or grassland.

HEP has served as the basis for development of a variety of nonmonetary evaluation techniques. The applications of HEP have been successful under a variety of circumstances, but there are some shortcomings with these models in addition to those described in Chapter II. Two important shortcomings are technical. The modifications of HEP and its variants are often ad hoc, and important ecological functions and values can be overlooked, since the models concentrate on indicator species. Another shortcoming that presents practical difficulties is the need for extensive field testing and data collection. Finally, there is the political problem presented by HEP's outputs in habitat units. The lay public is unfamiliar with this concept. This could greatly compromise the political support that is needed for the approval and funding of environmental projects at the Federal and local levels.

Following are some to the positive aspects of current, species-based versions of HEP:

- Subjectivity is reduced through the measurement of physical, chemical, and biological parameters;

- Critical species can be targeted for evaluation;

- The models require consideration of the indicator species' total habitat requirements; and

- Models can be modified to reflect local conditions.

HEP also has significant shortcomings that limit its utility as a nonmonetary evaluation technique:

- Many models have not been field tested;

- Data requirements can be expensive and time consuming;

- Models may not be sensitive enough to evaluate project effects; and

- Models are not watershed- or ecosystem-based.

Habitat Management Evaluation Model

The Habitat Management Evaluation Model (HMEM) was developed by USFWS for formulation of cost-effective mitigation plans. HMEM links HEP software to ecosystem management models to predict the changes in ecosystem outputs that would result from alternative management actions. The intent is to develop the most effective sets of management activities for different mitigation project scales and budgets.

Pennsylvania Modified Habitat Evaluation Procedures

The Pennsylvania-Modified HEP (PAMHEP) is a simplified version of HEP-80 (Palmer et al., 1980). This model was developed by the State of Pennsylvania in conjunction with the Corps, USFWS, and other Federal resource agencies. Like HEP-80, PAMHEP is a species-based model. The most significant difference between the two models is that PAMHEP has a more streamlined sampling procedure. It is limited to fish and wildlife applications.

Habitat Evaluation System

The Corps is very familiar with HEP for nonmonetary environmental evaluation. The Lower Mississippi Valley Division (LMVD) used HEP to develop the Habitat Evaluation System (HES). HES is a habitat-based system, since it is based on HEP-76. HES was specifically designed to evaluate the quality of different habitat types in the LMVD and compare the relative environmental impacts that could be expected from alternative water resources projects (USACE, 1980). It has specifically targeted bottomland hardwood forest ecosystems, which are common in LMVD.

HES utilizes nine physical, chemical, and biological variables for habitat quality evaluations for specific plots and five variables for larger tracts. The plot variables collectively generate ecological characterizations of the forest and a profile of the physical features of the plot. The variables are applied to standardized curves to obtain the HSI. The standardized curves were developed for hardwood bottomlands in the Lower Mississippi Valley, and the applicability of HES to other settings is limited.

Wetland Evaluation Technique

Under the Wetland Research Program, the Corps also has developed the Wetland Evaluation Technique (WET) for the estimation of wetland values and functions. It is based on the Federal Highway Administration's method for identifying the physical, biological, and chemical functions of wetlands (Adamus & Stockwell, 1983). WET uses a series of predictive variables to estimate the values and functions of wetlands. The model was designed for initial, rapid assessments of wetland functions and values, but it is sufficiently flexible for other applications, including: (1) comparison of different wetlands; (2) establishing priority project lists; and, (3) identifying critical habitat for more detailed research. WET is less widely accepted than HEP and HES and has been criticized as excessively subjective (The Greeley-Polhemus Group, 1991).

Wetlands Value Assessment

The previously mentioned task force established by the Coastal Wetlands Planning, Protection, and Restoration Act established the priority project list using the Wetland Value Assessment (WVA) methodology developed for this purpose. The WVA is a modified version of the HEP. It is designed for application to Louisiana coastal wetlands. It quantifies with- and without-project changes in wetland quantity and quality that are anticipated for alternative wetland projects. The results of the WVA are Habitat Unit values, by target year, for each wetland project. Cost data can then be developed to evaluate projects in terms of costs per habitat unit over the 20-year life of the wetland projects.

Wildlife Habitat Appraisal Guidelines

The Wildlife Habitat Appraisal Guidelines (WHAG) is another HEP variant. WHAG was developed by the Missouri Department of Conservation and the U.S. Soil Conservation Service for applications in the Missouri River Valley (1990). Most of the changes to HEP were made to increase the user friendliness of the models and the data sheets.

Habitat Assessment Technique

The Habitat Assessment Technique (HAT) was developed primarily for the evaluation of bird habitat (Cable et al, 1989). This technique generates an index score for bird diversity. It can be used for broad ecological assessments when birds are selected as the indicator species.

Synoptic Approach for Wetlands Cumulative Effects Analysis

The Synoptic Approach for Wetlands Cumulative Effects Analysis (SAW) categorizes entire landscapes. It is valuable as a reconnaissance tool for rapid assessment of wetlands landscapes (Abbruzzese et al, 1990). The SAW analysis is particularly valuable as a scoping tool for more detailed wetlands assessments.

Connecticut/New Hampshire Method

The Connecticut/New Hampshire Model (C/NHM) is used to rank a series of freshwater wetlands in these two states (Amman and Stone, 1991). It may also be applicable to other areas in New England.

Hollands-Magee Method

The Hollands-Magee Method (H-MM) was designed for the evaluation and ranking of freshwater wetlands (Hollands and Magee, 1985). It is applicable to New England and the Midwest. It can be used to rank a series of wetlands based on functional uniqueness relative to the others in the series.

Ontario Method

The Ontario Method (OM) was developed through a joint effort of the Ontario Ministry of Natural Resources and the Canadian Wildlife Service (Euler et al., 1983). It can be used to evaluate and rank a series of wetlands in Ontario south of the Precambrian Shield.

Bottomland Hardwood Community Habitat Evaluation Model

The Bottomland Hardwood Community Habitat Evaluation Model (BLH) was designed for applications in the southeast United States (Schroeder et al., 1993). It develops a habitat suitability index for an ecological community rather than an indicator species as in HEP. The emphasis of this model is on habitat quality for wildlife.

Wildlife Habitat Appraisal Procedures

The Wildlife Habitat Appraisal Procedures (WHAP) were developed for evaluation of the wildlife impacts of water resource development projects in Texas (Texas Parks and Wildlife Department, 1991). It generates an index on the basis of three criteria: biological habitat, significance to protected species, and acquisition/administration potential.

Tidal Wetlands Evaluation

The Tidal Wetlands Evaluation (TWE) methodology was developed as part of a master's thesis at Duke University (Tippett). It is applicable nationwide to coastal wetlands for evaluating and ranking a series of wetlands, including natural and created wetlands. The TWE methodology queries the user about the characteristics of the wetlands and determines their extent and value.

Many of the above methodologies are able to evaluate and rank a series of alternative environmental projects. For HEP and its descendants the evaluation is in terms of species-specific habitat units. Other nonmonetary evaluation techniques assess changes in ecosystem outputs with other units, including acres of wetlands and waterfowl use days. These nonmonetary units are effective for comparison of similar or proximal environmental alternatives (i.e., in addressing the "site" question). However, they are of little use in determining efficient allocations of resources for environmental projects for distant or dissimilar ecosystems. This shortcoming with respect to the "portfolio" question has given additional impetus to the development of monetary valuation methodologies.

MONETARY VALUATION TECHNIQUES IN FEDERAL AGENCIES

Although there has been a great deal of academic research on monetary valuation of environmental resources, there has been limited progress in incorporating monetary environmental valuation techniques into Federal resource management and regulatory programs. The EPA and NOAA have initiated some monetary valuation programs. In addition, the Corps has an extensive history of developing recreation evaluation tools which assess qualitative changes in resource conditions.

The explanation for the limited research and application of monetary valuation techniques lies in a complex combination of the shortcomings of available monetary valuation tools and the organizational contexts of the different Federal resource management agencies. While this is disconcerting with respect to the unfulfilled promise of monetary valuation of environmental resources, it reinforces the relevance of the EEIRP.

Alternative Techniques

A variety of monetary valuation techniques for environmental resources has been developed. As indicated in Figure I-1, these techniques often generate monetary valuation inputs to benefit-cost analysis. Monetary valuation includes market-based, surrogate-market, and nonmarket techniques. These techniques are outlined below. For more detailed treatments of these methods see Freeman (1979, 1993).

Market Based Techniques

Changes in Factors of Production. When an environmental resource has value as an input in a productive process, its monetary value can be easily calculated. This technique is limited to those resources that can be used as inputs, and the inferred value of that resource may understate its true worth to society. An example of such a situation might be the change in water treatment costs associated with a manufacturing process that requires clean water as an input.

Weak Complementary Goods. If the enjoyment of consuming a market-measurable service (e.g., fishing) is enhanced by a nonmarket environmental service (e.g, water quality), the demand for the market service should increase with an increase in the complementary environmental service. When the enjoyment of the environmental service requires purchase of the market good (as in this case) or if the service can be considered as a characteristic of a market good, it is possible to measure the value of a change in the environmental service that is based on the demand for the market good.

Defensive Expenditures. Defensive expenditures are made either to prevent or to counteract the adverse effects of pollution. In effect, it is spending on a good that is a substitute for increased environmental outputs (e.g, water quality). Conversely, an increase in the environmental outputs should reduce defensive expenditures. The marginal change in defensive expenditures represents a willingness to pay for the incremental change in the environmental outputs.

Next Best Alternatives. When environmental resources have private goods that are viable substitutes, the value of these resources can be inferred from the market value of the substitutes. An example is provided in the above DOE effort to estimate the value of wetlands water quality functions based on similar functions provided by a water treatment plant. Two shortcomings of this market-based technique are that few environmental resources have such substitutes, and the market value may not reflect the true value to society.

Surrogate-Market Techniques

Travel Cost Method. The travel cost method is a well established technique for valuing the recreation value of environmental resources. The travel cost in time and money is considered representative of the willingness of the user to pay for access to that resource. The limitations of these surrogate-market techniques are that it only gauges the recreational value and does not consider other values of environmental resources to society, nor does it allow for nonuse valuation.

Hedonic Prices. The concept of hedonic prices is that the prices and quantities of private goods purchased in the marketplace often reflect the value of associated public goods. Hedonic prices have been developed for environmental resources through property prices, travel costs, and wages. Heaney (Appendix A) discusses the merits of this surrogate-market technique with respect to environmental valuation. However, the challenge for valuation of environmental resources is the inability of consumers to select their most preferred bundle of characteristics of the specific private goods (Freeman, 1993).

Nonmarket Techniques

Contingent Valuation Method. The contingent valuation method (CVM) is the most accepted nonmarket monetary valuation technique. Its strengths and weaknesses are addressed in detail in the appendices (especially Schkade, Appendix B). CVM is based on a survey of individuals to directly build a demand curve for the subject good or service and discern the value of the service based upon the public's willingness to pay. While CVM has well-established shortcomings, this nonmarket valuation technique nevertheless has been recognized in Federal environmental programs.

One Federal application has been through the EPA's administration of the Comprehensive Environmental Response, Compensation, and Liability Act of 1986 (CERCLA). This statute allows use values of environmental resources to be estimated with hedonic process and CVM. Despite the recognition of CVM, a case study of the Oil Pollution Act of 1990 (OPA) may illuminate the difficulties that Federal agencies face in utilizing CVM for environmental resource valuation even when specifically directed by legislation.

Among its provisions, the OPA is responsible for determining appropriate compensation for oil discharges into U.S. coastal and inland waterways. It charges NOAA with the development of procedures for assessing the damages from oil spills. To comply with this legislation, NOAA assembled a Contingent Valuation Panel (co-chaired by Kenneth Arrow and Robert Solow). As indicated in the following excerpt from the Federal Register, the controversy surrounding CVM created great difficulty for NOAA's development of these regulations for the OPA:

> "This (sometimes acrimonious) debate has put the National Oceanic and Atmospheric Administration (NOAA) in a very difficult spot. NOAA must decide in promulgating the regulations under the Oil Pollution Act whether the CV technique is capable of providing reliable information about lost existence or other passive-use values. Toward this end, NOAA appointed the Contingent Valuation Panel to consider this question and make recommendations to it".

Federal Register, 58(10) p. 4603

The panel reviewed the CVM in great detail, examined the strengths and shortcomings of the technique, and developed guidelines under which any CVM should be conducted. In addition, the panel prepared a detailed research agenda directed toward development of a standard damage assessment for oil spills. The panel concluded that:

> "... CV studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values. ... The phrase 'be the starting point' is meant to emphasize that the Panel does not suggest that CV estimates can be taken as automatically defining the range of compensable damages within narrow limits".

Federal Register, 58(10), p. 4610

Despite these limitations of CVM and the challenges in implementing this technique on a programmatic basis, this case study also holds some promise for increased application of CVM. The panel clearly recognized nonuse values as a legitimate category of oil spill damages, and CVM is the most likely technique to elicit such values in a monetary framework.

SUMMARY

The Federal resource agencies have ongoing research and application programs for monetary valuation and nonmonetary evaluation of environmental resources. Most research activities are focused on the refinement of nonmonetary evaluation techniques. The application of nonmonetary techniques by Federal resource agencies is expected to continue into the future. This can be attributed to increased Federal environmental activities, new agency management parameters, and the cost-focused analyses as decision-making frameworks. The techniques for nonmonetary evaluation are well-established, and this positive experience undoubtedly adds momentum to the application of these methodologies.

In contrast, the prospects of monetary evaluation are uncertain. There have been a limited number of applications by Federal agencies to date, and future applications (at least in the near future) appear to be limited as well. Much of this can be traced to the difficulties with assigning monetary values to environmental resources and the selected usage of benefit-cost analysis by Federal agencies. Nevertheless, there are aspects of Federal environmental management and directions of current monetary valuation research that are promising for future application of these techniques. Among these are the likelihood of greater incorporation of benefit-cost analysis in Federal decision making and the need for monetary valuations to make efficient and defensible allocations of scarce resources to environmental projects.

In many ways, the continued refinement of nonmonetary techniques will spur research and development of monetary valuation methodologies, especially CVM. Significant obstacles to effective use of CVM are meaningful descriptions of the condition of an ecosystem, the impacts of management actions, and the importance of environmental services.

The diversity of research and applications of monetary valuation and nonmonetary evaluation techniques by Federal resource agencies creates significant risks of duplication of research efforts. This hazard should be precluded by increased interagency cooperation and coordination on environmental evaluation. Since the Corps is somewhat unique in its traditional reliance on benefit-cost analysis and its address of the "site" and "portfolio" questions regarding environmental activities, it should actively facilitate interagency coordination on environmental evaluation. There are many different avenues for such coordination, including formal and informal cooperation an coordination at the executive and/or staff levels.

In Chapter II and the appendices, available monetary valuation tools were identified, and the challenges of their practical application were discussed. This chapter has examined the monetary valuation and nonmonetary evaluation activities of other Federal agencies. While other Federal agencies face similar needs for and challenges of environmental evaluation, no significantly different evaluation tools or programs have been identified. In the following chapter, the institutional considerations of greater usage of environmental evaluation methodologies in Corps programs are addressed.

IV. CORPS INSTITUTIONAL SETTING FOR IMPLEMENTATION

Thus far, this report has focused on and discussed the principals and techniques of the evaluation of environmental resources. While elaboration on these concepts are warranted for further research (see next chapter for specific recommendations), this chapter identifies the realm for which these techniques can realistically be used within the Corps environmental plan formulation process. The Corps has a "way of doing business" which is driven by a variety of attributes including standard planning procedures, legislative mandates, past experience, personnel, and agency culture. In order to recommend an avenue for environmental evaluation that will result in effective how-to planning procedures (the ultimate goal of the EEIRP), it is important to understand the Corps institutional setting.

This chapter highlights some of the salient institutional characteristics and constraints of the Corps environmental plan formulation process. It includes discussions of the Corps traditions in project development, current guidance on environmental projects, and other planning parameters, including resources, local sponsorship, authorizations, and project scales.

TRADITIONS IN CORPS PROJECT DEVELOPMENT

Within the Corps traditions of project development are three main elements: agency culture, procedures for developing Civil Works projects, and the plan formulation process. These traditions provide a historical baseline for subsequent discussions of the current guidance of environmental projects and other decision-making contexts.

Agency Culture

Development of environmental projects within the Corps Civil Works program follows many of the same procedures and standards that the Corps has found successful for decades. These procedures include multidisciplinary efforts within the Corps as well as interagency coordination. Many of these procedures are documented through Corps guidance publications, engineering circulars, policy memorandums, etc. In many cases, unique features and considerations for developing environmental projects are documented explicitly in this guidance. While opportunities for departure from traditional Civil Works procedures are clearly identified, there is a residual mindset, which is founded on a history of engineering success and quality, that affects the development of environmental projects within the Corps. The most prominent example is justifying projects on the basis of NED. Corps policy (which is discussed later in this chapter) clearly states that NED determinations for environmental restoration and mitigation projects are not mandatory, but there is a underlying tendency within the Corps community toward NED-based procedures whenever possible, even for environmental projects. In fact, some parties outside the Corps (e.g., other resource agencies, local sponsors) have been moderately disappointed when the Corps has not pursued NED justification for environmental projects.

Some traditional practices within the Corps have to be revisited in light of environmental projects (which is the chief motivation of the EEIRP). Some of this change will be instituted through Corps policy and guidance, but a portion of it is more deeply-seated in Corps culture. It will take time for this evolution to occur. This line of discussion is not suggesting Corps operations are or will be malaligned with policy, only that a very real tradition and culture exists within the Corps and that this is related to the development and proliferation of environmental evaluation techniques for Corps planners.

Procedures for Developing Civil Works Projects

The traditional Civil Works development process for any project including environmental restoration and mitigation can be characterized in six steps. They are *Perception of Problem, Request for Federal Action, Study the Problem and Prepare Reports, Report Review, Congressional Authorization, and Project Implementation*. These steps are illustrated in Figure IV-1. Each step contains specific requirements to advance the study to completion.

Perception of the Problem occurs when a local person, group, or government identifies a water resources problem of Federal interest, including flooding, shore erosion, or navigation. Such problems cannot be resolved by local government action due to jurisdiction or limited capability or resources. The inability of local government to address the problem results in a *Request for Federal Action*. Local officials request that the Corps assess the situation and determine what authorization is required to investigate the problem. If the project does not fall under a Continuing Authorities Program, the local officials contact congressional representatives to seek project authorization through the Public Works Committee. Authorization can only be granted following an investigation of the problem, or if special legislation is approved by Congress. The funds are typically provided in the annual Energy and Water Development Appropriations Act. These authorizations traditionally require a cost-sharing agreement with the local sponsor(s).

Once funding has been authorized for a project, the local District is assigned to *Study the Problem and Prepare Reports*. The District has 12 to 18 months to perform a reconnaissance study and produce a report of its findings. The report should include a draft Environmental Impact Statement and follow the P&G. Local public officials should review the information and determine local support for the action. If the project is approved by the Corps and local officials, a cost-sharing agreement is developed and the project enters a feasibility phase that lasts 18 to 36 months. The feasibility study produces a Definite Project Report that is submitted to the Corps Division Office.

The *Report Review* occurs at both the Division and Washington levels. Comments are solicited from the Washington Level Review Center, the public, and any other Federal and state agencies. The report and all commentary are submitted to the Chief of Engineers for review.

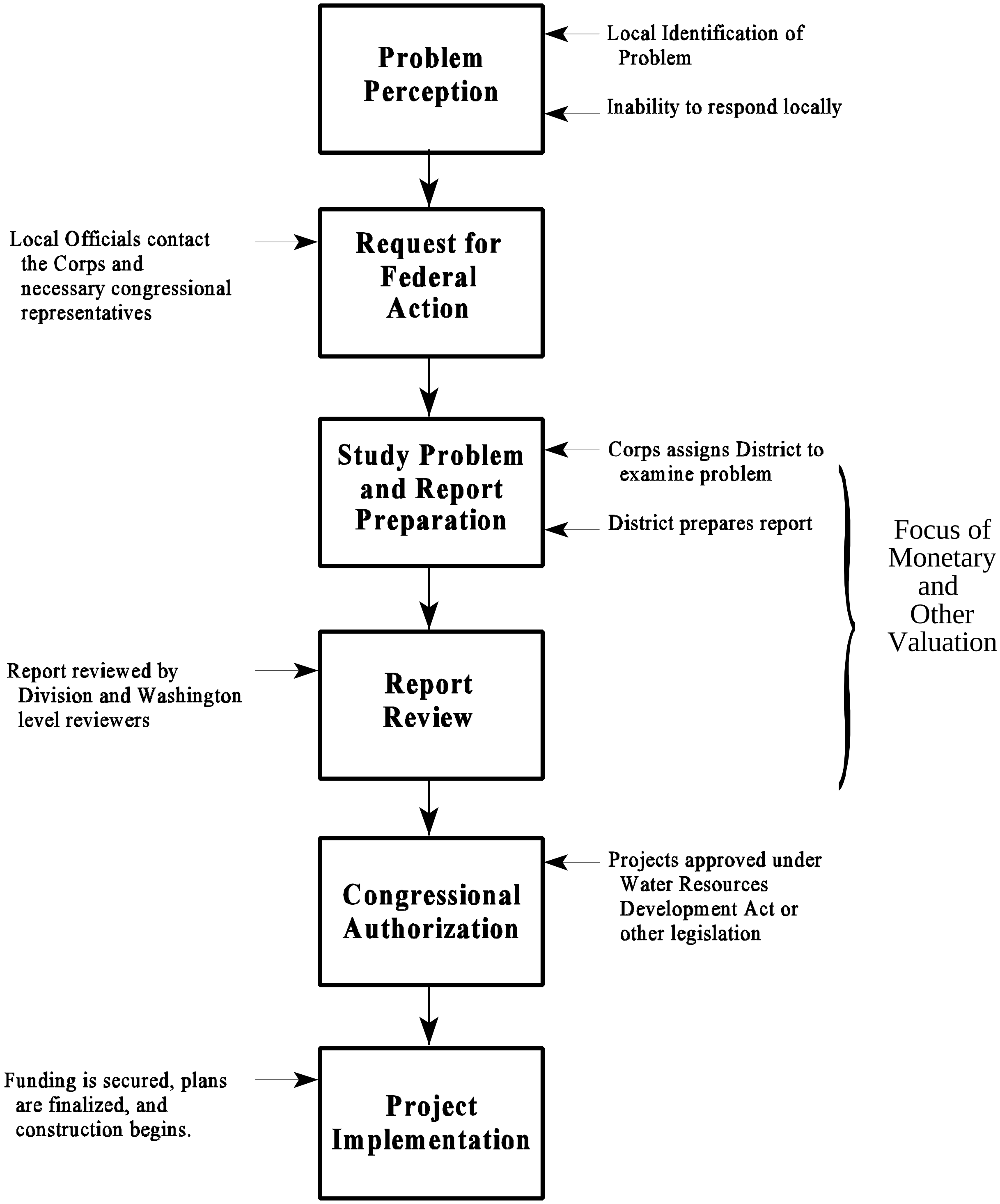

FIGURE IV-1
MODEL OF TRADITIONAL CORPS PROCESS FOR CIVIL WORKS PROJECTS

The Chief of Engineers prepares a final report that is reviewed by the Assistant Secretary of the Army (Civil Works) and the Office of Management and Budget.

Congressional Authorization is granted if the House Committee on Public Works and Transportation and the Senate Committee on Environment and Public Works pass a bill containing the project under the annual Water Resources Development Act. Authorization also can be provided through other legislation or committee resolutions if the Federal cost is less than $15 million. *Project Implementation* occurs after the funding sources have been finalized and the non-Federal sponsor has agreed to their responsibilities for implementation, operation, and maintenance of the project. The Corps manages the construction of the project.

The six-step process shown in Figure IV-1 satisfies not only protocol within the Corps but also within the Federal government. It is rather broad from the perspective of examining environmental evaluation techniques, but it is important to understand the larger scheme to which the these activities will support.

Major Steps in the Planning Process

Another six-step process that is standard in Corps project development describes the plan formulation procedures. These steps, shown in Figure IV-2, are closely aligned with development of the reconnaissance and feasibility reports described in the second and third steps of the project development process illustrated in Figure IV-1. It is during the plan formulation process that the Monetary and Other Valuation work unit will play an important role.

These steps, which are outlined in the P&G, are *Specification of Problems and Opportunities, Inventory and Forecast of Water and Related Land Resource Conditions, Formulation of Alternative Plans, Evaluation of the Effects of Alternative Plans, Comparison of Alternative Plans,* and *Selection of Appropriate Plan*. There are times during this process that require repeating one or more of the steps to sharpen the focus of the study, especially if new data are acquired during the study process.

The *Specification of Problems and Opportunities* entails the identification of the problems and the opportunities for alleviating them. Problems and opportunities are to be identified with respect to Federal goals and specific State and local concerns. This is where a clear statement of environmental significance is needed. An explanation of current conditions and the desired future outcome are expected. The full range of preferences by stakeholders affected by the development of a project should be discussed.

Inventory and Forecast of Water and Related Land Resource Conditions is the assessment of what the actual conditions in the study area are, and what the future conditions should be based on existing conditions. This assessment is used to develop the planning objectives for the study.

Once the planning objectives are identified the *Formulation of Alternative Plans* begins. Systematic formulation of alternatives is expected to insure the evaluation of all reasonable

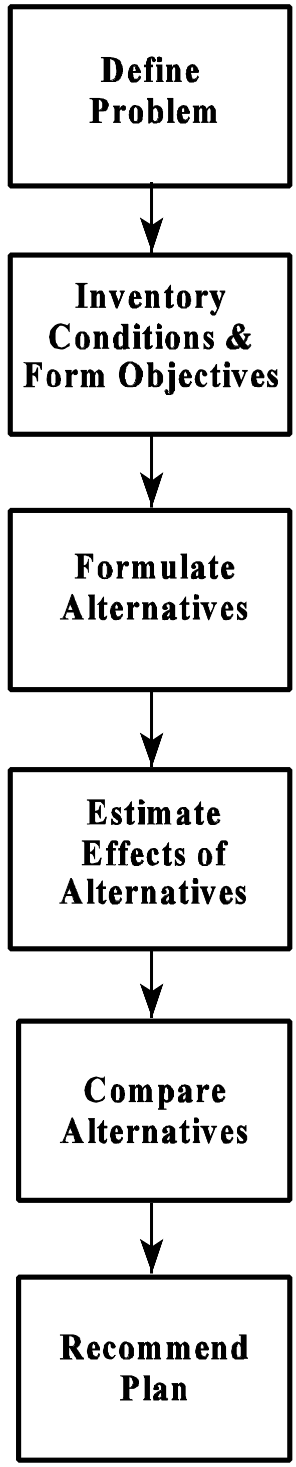

FIGURE IV-2
PLAN FORMULATION STEPS

alternatives. This is one step that is executed at least several times, as additional alternatives and improvements to existing alternatives are recommended throughout the study process.

Alternatives that are deemed appropriate for meeting project goals enter the *Evaluation of the Effects of Alternative Plans* step. The effects of recommended alternatives are compared against what would happen to the study area without implementing any projects. Social values are assigned to the technical information generated with each recommended alternative. It is at this stage where the planner embraces environmental evaluation methodologies.

The *Comparison of Alternative Plans* is the appraisal of the recommended alternatives based on the social values assigned during the evaluation step and how they meet the planning objectives for the study. During this step, stakeholders and other interested members of the public provide comments regarding what they perceive to be the most appropriate alternative.

Finally, *Selection of the Appropriate Plan* takes place. All the information gathered during the comparison step is taken into consideration to select the most appropriate alternative for project implementation.

PRESENT CORPS GUIDANCE ON ENVIRONMENT PROJECTS

In 1990, the Assistant Secretary of the Army of Civil Works (ASA(CW)) indicated that environmental restoration and mitigation projects should be given equal status with flood control and navigation projects. Draft guidance has indicated that multidisciplinary teams should be assembled to develop project proposals that account for the complexities of environmental projects. Many elements of the traditional Corps planning process are applicable to planning within the environmental arena.

However, implementation of environmental projects within the traditional planning framework has created some challenges in the preparation and review of reconnaissance and feasibility reports. The predominant issue is the use of a traditional benefit-cost ratio for Civil Works Projects to determine the projects contribution to NED. Environmental projects require the determination of the most cost-effective approach for implementing a project, describing the federal interest in a project and presenting monetary and other values that are expected to result from project implementation. Wetland and other water-related projects have been recognized as possessing an inherent benefit value to the Nation. Since these benefit values are not all readily identifiable or associated with a monetary value, NED determinations are not mandatory.

Guidance Regarding Environmental Approaches

Guidance to assist planners in developing environmental projects exists in the form of memoranda from the ASA(CW), the Chief of Engineers, and members of Headquarters staff. This information is designed for use in the traditional Civil Works planning process. On 25 June 1990 the

ASA(CW) issued a "Statement of New Environmental Approaches." This was done to facilitate the President's goal of maintaining and restoring the health of the environment. As stated in the opening, "Creative use of the extensive, existing expertise and authorities of the Corps of Engineers in support of the President's goal is emphasized."

Civil Works funds can be used to restore environmental levels to historic values if several conditions are met. The proposal should be justified with monetary and nonmonetary benefits, involve a cost-sharing partner, and be located in an area where a Civil Works project contributed to the degradation of the area, or where restoration is achievable through modification of an existing Civil Works project. It is important to note that a project is not solely justified by a least-cost alternative. The linkage and indication of federal interest in the project must also be justified.

If the planning circumstances meet the above conditions, there are a number of approaches to promote fish and wildlife restoration within the Civil Works mission. First, existing authorities should be used to plan and execute the added mission emphasis on environmental restoration. This includes giving priority status to fish and wildlife outputs and meeting the goal of "no net loss of wetlands." Next, facilities and lands of existing Civil Works projects should be operated and maintained to contribute to the restoration of fish and wildlife resources while maintaining original authorization purposes. Another approach is the full consideration of restoring environmental values in planning new projects. Not only does this emphasize new approaches to resolving water resource problems, it also gives priority rating to projects that avoid or fully mitigate adverse environmental effects.

Coordination with other agencies is another goal in the new Corps mission. Joint evaluations of environmental policy under the regulatory program of the Clean Water Act are important to ensure its proper implementation. Cooperation with other agencies in planning and budgeting environmental restoration projects can also effectively achieve environmental restoration goals because of the combination of each agency's expertise. This expertise can be contributed to reimbursable work conducted under authority of another agency. In addition, this expertise can be employed to improve environmental program management at military bases that are funded through military appropriations.

Guidance Regarding Environmental Restoration

On 7 March 1991, the Director of Civil Works dispensed a memorandum: Policy Guidance Letter No. 24, "Restoration of Fish and Wildlife Habitat Resources." This memorandum provided additional direction to the use of previously issued guidance, including the 25 June 1990 statement from the ASA(CW) (described above).

The memorandum defines fish and wildlife restoration as "measures undertaken to return fish and wildlife habitat resources to a modern historic condition." The restoration goal is "to reverse the adverse impacts of human activity and restore habitats to previous levels of productivity but not a higher level than would have existed under natural conditions in the absence of human activity or disturbance."

The above memorandum contain four key policy points. The first is the need for linkage of the proposal to a Corps project. Linkage is justified if a previous Corps project contributed to environmental degradation, or if restoration is cost-effective by modifying an existing Civil Works project. Proposals for these projects require 25 percent local cost-sharing and full non-Federal operations and maintenance of the completed restoration.

The second policy point is that restoration measures must address significant resources and be justified with an incremental analysis of both monetary and nonmonetary benefits regarding the most effective implementation measure. It is recognized that the least cost alternative may not provide the most beneficial restoration approach. Qualitative descriptions of benefits are encouraged.

The third policy point states that, due to current budgetary constraints, implementation of the Water Resources Development Act of 1986 to mitigate wildlife resource damages at existing projects under Section 906(b) cannot occur. Funding is also not available for the enhancement of fish and wildlife resources under Section 906(e) or beneficial habitat modification for fish and wildlife under Section 704(b). Later in the memorandum, it is suggested that restoration an be achieved through authorization of Section 1135(b) of the Water Resources Development Act of 1986, Section 216 of the Rivers and Harbors and Flood Control Act of 1970, or the General Investigation program.

Guidance Regarding Recreation

The incorporation of environmental projects into the Corps mission has raised guidance issues regarding recreation benefits, because most environmental projects have inherent recreation values. A memorandum was issued by the ASA(CW) on 10 July 1986 to clarify the role of recreation in Civil Works projects. The policy of the administration is to reduce Federal competition in providing recreational opportunities. Federal funds are only to be used for projects in which recreation benefits are less than 50 percent of the total benefits. Recreation benefits should not exist independently of other benefits provided, and they should result from the creation of other project purposes. Section 119 of the River and Harbor Act of 1970 indicates that projects that rely on recreation evaluation procedures are recreation projects.

Studies conducted under the Civil Works program should not focus on recreation. The sum of nonrecreational benefits and jointly produced recreation benefits should exceed project costs when independent recreation elements are not included. Recreation benefits should not exceed nonrecreational benefits. This policy also applies to the planning and engineering program.

This policy was created to reduce the Corps role in the construction of recreation projects. However, it has serious implications with regard to the development of environmental project values and benefits. Because environmental projects have inherent recreation benefits, it causes an additional challenge for planners attempting to determine appropriate benefit values.

IMPLICATIONS OF INSTITUTIONAL CONSTRAINTS ON PLANNING ENVIRONMENTAL PROJECTS

As mentioned in the opening discussion of this chapter, the ultimate goal of the Monetary and Other Valuation work unit is to assist Corps planners in the plan formulation process. Many of the techniques described in earlier chapters have been successfully used in the Corps and elsewhere to suggest values for environmental services. There are other techniques though, that while theoretically-sound and scientifically-based simply do not fit into the Corps institutional structure. This mismatch goes beyond the notions of agency culture, but rather is driven by tangible and practical constraints resulting from limited time and resources for the environmental evaluation process.

The following section focuses on these practical constraints by examining planning timelines, expertise, data, and project authorization requirements and limitations. Where applicable, insights gained from interviews held with Corps planners, resource agencies, and local sponsors in the development of *Compilation and Review of Completed Restoration and Mitigation Studies in Developing an Evaluation Framework for Environmental Resources* (Feather and Capan, forthcoming) are used in the discussion below.

Resources

Time

Most environmental evaluation activities are conducted during the feasibility stages of project development, although benefit categories, outputs and a considerable amount of physical data are collected and defined in the reconnaissance stage. The feasibility stage can take up to 36 months, and the reconnaissance should not exceed 18 months. Planning formulation for Section 1135(b) projects is typically required in less time, usually 12 to 18 months.

These time limitations have a direct bearing on what techniques can be used in the valuation process. These limitations are further defined by the budgets allowed for planning studies. The collection of primary data, such as travel cost surveys, can sometimes be a multiple-year effort. In many cases, especially Section 1135(b) projects, this timing factor makes travel cost surveys difficult to include in plan formulation. Also, models of ecosystems that require detailed data from the site which are not part of the EIS or standard survey work limit their use in the context of a 12 to 18 month study process.

Use of benefits-transfer technologies could greatly enhance the planner's ability to examine many environmental benefit categories. If benefit calculations were compiled from other sites, planners could generate high- and low-value scenarios for environmental services being examined. While there are some empirical weaknesses of such approaches, benefits-transfer has a great advantage that it can be used in a relatively short amount of time.

Data

One of the biggest constraints that the planner faces in determining a technique or approach for environmental evaluation is the availability of data. There is a direct relationship between the types of models that can be used and data availability. No matter what models are developed for the evaluation process, if the data are not readily attainable for the site under study, the models or techniques are of limited use to the planner.

There are some cases where the data collection may not be so burdensome. Valuable support can be realized if data or models that were generated for the original Corps project are available. Also, in some cases other resources agencies may be regularly collecting data that could be input into appropriate models. If it is a matter of updating a database or recalibrating a model, then the planners have a better opportunity to use these techniques.

Where long-term monitoring and data collection are in place, some of the data short-comings are relieved. The ecological models such as HEP that are partially driven by vegetation types and other physical parameters can be updated or tracked if data are regularly collected and site maps are kept current. Other forms of physical data, such as standard water quality parameters, fish and wildlife populations, etc. that are collected regularly at a site or watershed, are valuable to the nonmonetary evaluation process. Not only does diligent long-term data collection make data available to the plan formulation process versus having to collect data as part of the plan formulation critical path, but it also supports advanced ecosystem modeling efforts. Collection of pre- and post-project data is crucial to understanding the impacts of management actions.

The long-term monitoring effort under the Upper Mississippi River System Environmental Management Plan (UMRS-EMP) illustrates one of the more aggressive data collection efforts in the Corps. While there are many analytical benefits tied to this database, including more reliable and readily-available data for environmental evaluation, it requires a significant budgetary investment to support the staff and equipment to maintain the database. In most cases throughout the Corps, planners have to rely on much less data in the environmental evaluation activities.

Expertise

The environmental benefit categories that fall under the realm of use-values (refer to Figure I-1), especially those described by market-based techniques, are for the most part supported by approaches offered in the P&G (see Heaney, Appendix A). For example, if a proposed wetland project provides flood control, the techniques to quantify the benefits for flood control are relatively straightforward and can readily be developed by Corps planners. Similarly, if recreation benefits are found to be pertinent, standard methods are well within the Corps planners grasp for placing value on that element of environmental service.

Consideration and quantification of nonuse values is somewhat less pronounced in the present set of analytical tools common to Corps planners. This probably reflects the more general status of nonuse values in environmental evaluation where inclusion of such values is still debated (see discussion in Chapter II). While the Corps planning community is certainly abreast of CVM, the chief means for quantifying nonuse values, actual application or even consideration of application to environmental mitigation and restoration projects is presently rare within the Corps. None of the case studies described in Feather and Capan (forthcoming) formally quantified nonuse values in the plan formulation process.

Most Corps districts have a working knowledge of the standard habitat models, such as HEP. Certainly, the hydraulics and hydrology models are within the Corps analytical realm through the standard series of models developed at the Corps Hydrologic Engineering Center. Successful application of the models to specific sites is, as mentioned earlier, a function of data availability.

Examination of cost-effectiveness of environmental project alternatives through incremental analysis procedures is a common practice by Corps planners. Corps reports and guidance are available for these procedures. One of the challenges that many planners face is the ability to estimate environmental outputs for a range of <u>realistic</u> project alternatives. This challenge is often spurred by data constraints.

Corps planners have opportunities for using other agencies in the evaluation activities. One of the more common strategies is to utilize the U.S. Fish and Wildlife Service (USFWS) for applications of HEP. Frequently, USFWS has up-to-date information and finds participation in its interest, especially if it is an environmental project. State resource agencies can also be valuable planning assets to the Corps planner. Special studies regarding monetary valuation through socioeconomic analysis can be conducted under contract.

Local Sponsor

There are several important issues regarding local sponsorship of environmental projects that are directly relevant to environmental evaluation methodologies. First, an appropriate local sponsor must be identified. This sponsor must have legal authority and the desire to participate in the Corps project. Second, coordination with the local sponsor must clearly outline the scope of Corps activities. In some instances, unrealistic expectations of local sponsors have complicated plan formulation processes. While the Corps planner may recognize the relevance of the local sponsors desire, it is simply outside the Corps authority to pursue certain features.

The local sponsor must be willing to cost-share the feasibility studies, project construction, and the O&M costs as appropriate to the particular project authorization. The local sponsor is an active partner in the plan formulation process and should be involved at every important planning juncture. In some cases, the local sponsor is also a valuable resource for data.

As an important stakeholder, the local sponsor must be open to the public involvement process and negotiation of the scope of the project and the trade-off among competing interests. The main forum for discussing competing interests found by Feather and Capan (forthcoming) was standard public meetings and informal negotiations such as meetings. Formal negotiation and trade-off analysis as discussed in Chapter II were used infrequently in the case studies examined.

Project Scale

Section 1135(b) Authorization

The purpose of Section 1135(b) authorization, developed as part of the Water Resources Development Act of 1986, was to provide a means of modifying structures and operations of water resource projects to improve the quality of the environment. These projects are to be formulated and constructed at a cost of less than $5 million with a 25 percent nonFederal cost-sharing agreement. No more than $25 million dollars will be appropriated for this authorization annually.

As of 10 May 1993, approval was given to Major Subordinate Commands to request funding not to exceed $2,500, for the preparation of an Initial Appraisal Report (IAR). Funds allotted to the preparation of an IAR count toward the total project modification costs with regard to cost-sharing agreements. The purpose of the IAR is to provide information for determining if a feasibility study for a possible Section 1135(b) project is necessary.

An IAR is to be concise but informative, and based on existing data. There are specific guidelines to follow for the development of an IAR, including the format of the document, how information is to be described, and the description of both tangible and intangible benefits. Although the format presented appears to be easily utilized for proposing project modifications, field personnel have indicated that $2,500 was not enough to adequately address each point within the IAR to present an accurate description for the project proposal.

The preparation of an IAR requires a significant amount of time. A traditional reconnaissance study is allowed 12 months for completion. There is no indication regarding the length of time allowed to complete an IAR other than that $2,500 funding limit. Like reconnaissance reports, approved IARs then enter a feasibility study phase. Although the feasibility study process follows the traditional framework for Civil Works projects, the notable difference is the way in which project benefits are assessed through nonmonetary evaluations. Common benefit categories developed in Section 1135(b) projects include waterfowl use days, consumptive/nonconsumptive user days, acres restored, habitat units, waterfowl counts, habitat suitability index, and average annual number of fledglings.

One difficulty encountered by planners is the justification of the projects with nonmonetary benefits. Guidance directs monetary and nonmonetary benefits to be jointly considered in the review of projects. However, Corps planners indicate that, in many cases, justification of the project to the public requires estimation of a project's monetary benefits. As mentioned earlier, the public may make requests or recommendations that fall outside of the project's authorization. Members of the public perceive the Corps as an organization that has the power to accommodate their requests, since the Corps is an extension of the government. Thus, when a recommendation is made by the public to include certain benefits, such as monetary recreation benefits, difficulties arise in explaining why they cannot be used, whether it is due to the extensive strain on monetary and other resources or if it is not accommodated under existing Corps policy.

Many planners contend that methods for determining recreation values could significantly contribute to benefit estimation, since environmental restoration projects have an inherent recreational aspect, whether it is consumptive or nonconsumptive. Planners expressed their difficulty in determining the role recreation benefits could play in study reports based on the current institutional setting.

Another challenge posed to planners is the development of appropriate benefit categories for Section 1135(b) projects. Planning budgets are small in comparison to other Civil Works projects, and this does not allow for a thorough investigation of benefit categories. Corps planners indicated that much of the guidance they received was in draft form, allowing some flexibility in the development of appropriate benefit categories. Planners were able to tailor benefit categories that emphasized the best features of the project. For example, HEP is a common and well-known means for assessing improvements in habitat. The environmental benefits of a project that produce a significant increase in waterfowl use days or improve the habitat quality of an area can be determined through the use of HEP.

In conjunction with the challenge of benefit categories, some planners reported difficulty in the review process, since there did not appear to be consistency in what reviewers desired for project benefits in feasibility reports. Some project planners have said that at the Division level the report should provide a greater emphasis on a particular benefit category. After those recommendations were accommodated, the next level of review indicated that another type of benefit was not adequately addressed. This inconsistency in review requirements has lead to inefficiencies in finalizing the study report for approval to begin construction, and also has caused a significant expenditure of resources for the project. This can be problematic if the total project cost is near the $5 million ceiling for Section 1135(b) projects.

Large-Scale Projects

While section 1135(b) projects are developed under a streamlined planning approach with a total project cost of $5 million to complete, there are environmental projects under other authorizations with costs that exceed $500 million. These authorizations exist in many forms, from continuing authorities to general investigations to new legislation. Each authorization provides guidelines to be followed, some more specific than others, but there is generally more money available for the planning process compared to Section 1135(b) projects.

The examination of benefit categories, although not constrained by the financial limits experienced with Section 1135(b) projects, still proves to be a challenging task for environmental planners. More resources are available for determining benefits, yet difficulties in determining acceptable measures still exist. In many cases, the additional planning funds make the environmental evaluation process more difficult because there are more analytical options to pursue. Larger projects also involve more stakeholders that will be affected by what is implemented. Some of the benefit categories developed for these project authorizations include habitat suitability index, habitat units, acres restored, water quality, water flow, waterfowl use days, hunting days, and National Economic Development (NED) benefits such as flood control, timber production, and recreation.

Large projects involve a significant number of people throughout the plan formulation process. This presents a significant challenge to the project manager, who must accommodate all the concerns and needs of the involved players. Numerous negotiations and trade-offs must occur. Therefore, it is difficult to readily select evaluation methods upon which all the players will readily accept.

The accommodation of the above perceptions and views can prove to be extremely challenging. As with Section 1135(b) projects, difficulty occurs in the review of these projects. After developing appropriate benefits justification to the local sponsor, the emphasis seems to change throughout the levels of review by higher authority. These changes of the benefit emphasis have been frustrating to local sponsors, because it appears that the project is not allowed to provide benefits they perceive as important. Additional strain on the local sponsors is attributed to the fact that they are contributing funds to a project for which they identified the problem. Thus, they should be aware of what benefits are attainable.

Most project planners do not pursue a benefit-to-cost analysis, since it is not required. However, some project planners include a benefit-to-cost ratio because it is viewed as a means for project justification in addition to nonmonetary benefits. In most cases, non-Corps members of the planning teams were in favor of estimating monetary benefits as part of the project planning. All members of these teams recognize there is difficulty in generating acceptable monetary values for all the aspects of environmental projects, but many would prefer a partial monetary evaluation to none at all.

Watershed-Specific Programs

The special regional authorizations provide a definitive set of rules regarding how reports are to be formulated and presented. Categories are defined and acceptable measures are identified. Some of these programs include the National Estuary Program, the Gulf of Mexico Program, the Coastal America Partnership, and the Marine Fish Habitat and Restoration Program. Two case study projects examined by Feather and Capan (forthcoming) present relevant examples of authorization for a geographic region that specifically define what benefits are to be examined in the study process. These authorizations are the UMRS-EMP and the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA).

The UMRS-EMP has an interagency group, the River Resources Forum, which is comprised of state and Federal agencies located along the Upper Mississippi River. These groups prioritize projects based on recommendations from a fish and wildlife workgroup that determines the biological feasibility of the proposals. The proposals are to be presented in the form of fact sheets. With regard to evaluations, HEP is deemed appropriate for determining project outputs.

There is an emphasis on physical measures in the UMRS-EMP and the benefit values that can be derived from them, because there is a long-term monitoring effort in place for examining the effectiveness of existing projects. For example, reduced turbidity in a pool allows for more aquatic plant growth. This, in turn, provides more food for waterfowl and some fish species.

The CWPPRA also provides guidelines for projects that are examined and ranked with a task force. The criteria appear to be more stringent, however, in that the primary criteria are based on the average annual cost per habitat unit. This assessment is based on analysis results from the WVA. Other benefits may be described in the project proposal, but they are considered to be secondary. Thus, this authorization's primary criteria is based on the cost-effectiveness of the project.

These watershed-specific authorizations are unique in several ways. First, there are clear definitions of what is required in the study report and how it will be examined. Second, each authorization has interagency work groups that prioritize the proposed projects for selection. Finally, the review and approval for the projects does not require sending reports past the Division level of the Corps, unless the cost of the project exceeds $2 million.

SUMMARY

This chapter has discussed the institutional setting of the Corps for environmental evaluation methodologies. It has focused on the goodness of fit of environmental evaluation methodologies into the Corps planning process. Some institutional constraints have been identified that limit the potential incorporation of environmental evaluation techniques in the Corps planning process. However, in many cases the techniques themselves are inappropriate for application in the contexts of Corps planning studies. Environmental evaluation is clearly an evolving field. Increased application of these methodologies in the Corps planning process will require significant modifications of the decision-making processes and the techniques themselves.

With its focus on the Corps as a institutional context for environmental evaluation, this chapter has identified some institutional constraints that reduce the receptiveness of the Corps to expanded roles of environmental evaluation methodologies. Some of these points of potential concern include: (1) the focus on the use of NED benefits, (2) a somewhat disjointed guidance to the Corps planner particularly regarding appropriate benefit categories and their measurement, and (3) a variety of other practical constraints on Corps field personnel, such as time and resources, data requirements, local sponsorship, and project authorizations and scales.

V. CONCLUSIONS AND RECOMMENDATIONS FOR RESEARCH

OVERVIEW

The previous chapters have presented the issues surrounding the monetary and other valuation and examined the challenges for planning environmental projects. Similar challenges with regard to environmental evaluation are being faced by all Federal resource agencies as they broaden the scope of their environmental activities. Chapters III and IV of the text examine the institutional constraints, opportunities, ongoing efforts for environmental evaluation in Federal resource agencies and the Corps in particular. The many dichotomies that surround environmental evaluation have been identified and discussed either explicitly or implicitly. These include contradistinctions between ecosystem functions and services, use and nonuse values, market and nonmarket techniques, benefit-cost and cost-focused analyses, research and application, academic and operational, and monetary evaluation and nonmonetary evaluation.

The elements of environmental evaluation illustrated in Figure I-1 and their interconnections have been addressed. The experts on the panel not only presented different perspectives on environmental evaluation but focused on different elements of the decision process as well. For example, Willard (Appendix D) generally concentrated on the natural history of a particular place and its ecological function/structure and services to society. Heaney (Appendix A) examined the benefit assessment of users mainly through the surrogate market technique of property value hedonics. Shabman (Appendix C) focused on the Corps as an institutional context for alternative environmental evaluation methodologies. Schkade (Appendix B) discussed the shortcomings of CVM and focused on the potential utility of negotiation and other group processes in environmental decision making. Russell (Chapter II) surveyed the different views and foci of the panelists and synthesized them into a spectrum of perspectives that highlights some of the interconnections in Figure I-1.

The panel of experts also shared their diverse perspectives on the services that ecosystems provide to society and how they could be addressed in the environmental investment decision process. Heaney organized in Table 1 of Appendix A the market-based, surrogate market, and survey-oriented goods and services that ecosystems provide to producers and consumers (Hufschmidt et al, 1983). Heaney concentrated on benefit-cost analysis as the decision framework and described the utility of property value hedonics in estimating user benefits. He also suggested that environmental externalities should not be included in monetary valuation, benefit-cost analysis, and, therefore, the investment decision. The paucity of *expost* analyses was identified by Heaney as a major problem, since the absence of historical databases of environmental services and benefits continues to hamper *exante* estimation of future project outputs.

Willard (Appendix D) presented a very different perspective on ecosystem services. He recognized the complexities of ecosystems (e.g., wetlands) and identifies their services to society, including recreation, water quality, flood control, streambank stabilization, and fish and wildlife habitat. However, he cautioned that the dynamic changes of some ecosystems over time challenge accurate assessment of their services to society. For example, Willard distinguished between the "absolute" wetness of a wetland and the "relative" wetness based on its historic conditions.

Shabman (Appendix C) used large watersheds (e.g., the Everglades) as an means to address the range of natural and social services that restored ecosystems can provide. In Table 1 of Appendix C, Shabman identified the natural/social services of large watersheds. Shabman suggested that planning objectives of watershed restoration can be measured by the restored watershed services or by the functional/structural changes of the watershed with associated changes in service quality or quantity.

Finally, Schkade (Appendix B) in his evaluation of CVM probed the psychological dimensions of determining individuals' valuations of environmental services. He identified internal contradictions and ambiguities as well as particularly challenging in the complex process of determining an individuals' true valuation of environmental resources.

GENERAL DIRECTION OF RECOMMENDATIONS

The Corps institutional arrangements for addressing environmental projects lead to two main avenues of recommendations. First, more clarification and guidance are needed regarding what to consider with respect to monetary valuation and nonmonetary evaluation during development of reconnaissance and feasibility reports. A related issue is understanding how much effort should be spent to develop the evaluation process during environmental plan formulation. Clear direction in this regard will dictate, in many cases, what benefit categories should be examined. The second group of recommendations is very much related to the first, that of methodology development. Once it is clear to the planners what should be measured, methodological support on how to measure benefits is crucial. The Corps planner is accustomed to very specific guidance and engineering regulations for direction during the plan formulation process. This planning need for addressing environmental projects is presently lacking in the Corps institutional setting.

While the main theme of the Corps and other resource agency practitioners is simply a request for clear direction, the academic front is looked upon to introduce theoretically sound and practical approaches for evaluation of environmental projects. The academic group offers several idealogies, methodologies, etc., but one theme stands out as a direction for research. That is, what benefits should be considered? This is very similar to the "plea" of the practitioner. What is offered below by way of recommendations focuses on clarification of monetary and nonmonetary benefit categories. Furthermore, direction and research toward the measurement of benefit categories are recommended, ranging from description of mathematical models to a negotiated assignment of value through interactive group processes.

The recommendations for research presented here are based primarily on the second meeting held with the panelists. This meeting was held after they had written their individual papers and were invited to make specific suggestions for needed research. The original recommendations have been refined to address particularly the practical analytical issues faced by Corps planners. The monetary valuation and nonmonetary evaluation approaches offered must possess the proper combination of reproductibility, comparability, and feasibility. Ideally, the product of these recommendations could be integrated with existing Corps methods, techniques, and structure where possible. The EEIRP timeline, which is about four years, essentially implies refinements and enhancements rather than full renovation of present practices. Therefore, it is expected that these tools will provide a supplement to the Corps environmental plan formulation process, instead of a drastic change in the foundations of plan formulation.

Some of the recommendations generated by this investigation into environmental evaluation methodologies are more applicable to other EEIRP work units than Monetary and Other Valuation. Although the EEIRP work units are all interconnected, the disaggregation of the program has great utility at this stage in the overall EEIRP effort. For this reason, the recommendations pertinent to the Monetary and Other Valuation work unit will be discussed separately from those applicable to other EEIRP work units. Note also that some of the recommendations have been initiated already in the EEIRP.

RECOMMENDATIONS FOR MONETARY AND OTHER VALUATION WORK UNIT

The recommendations for the Monetary and Other Valuation work unit are categorized below as literature and practice search, methods development, and demonstration case studies. These groupings are not sharply divided, nor are the specific recommendations confined to the categories in which they are listed. As a method is developed, for example, a supporting literature review will be required to provide appropriate background and design parameters. Furthermore, demonstration case studies will be used to refine and/or test newly developed tools and methods.

Within the broad categories, each recommendation is presented with accompanying discussion designation of the intended product, and general reference to estimated time needed to complete the proposed research. These recommendations are not in a ranked order, but are numbered for reference purposes.

The recommendations provided below cover a wide range of theories, topics, and methods. They are research topics that, if pursued, would move the Corps and other Federal agencies to a new level in understanding monetary valuation and other evaluation techniques. Recognizing budgetary constraints under the EEIRP, suggestions for next steps are as follows. It appears that there is an immediate need in the Corps planning community that could be relieved through pursuing the inventory of benefits categories (#2) and applying these findings to the development (#7) and testing (#9) of monetary and other valuation approaches designed to meet the respective planning challenges found in large versus small projects. This avenue of research would be a very appropriate supplement to the Corps forthcoming environmental plan formulation guidance.

It is also recommended that the interagency workshop (#7) be conducted in the near term. Many of the research issues suggested in the other recommendations could be discussed at this workshop. Most importantly, the Corps would have a firm understanding of what facets of monetary and other valuation are being addressed by other agencies and which areas the Corps should direct its efforts. These and the other recommendations for the Monetary and Other Valuation work unit are discussed below.

Literature and Practice Search

1. *Clarify role of nonuse benefits in environmental plan formulation*.

As environmental amenities receive the attention of economists, the challenge of recognizing and placing value on nonuse benefits has arisen. The three categories of nonuse benefits often cited are bequest value, the value of preserving/providing a resource to future generations; option value, the value of having the option to utilize a resource; existence value, the value of knowing a resource exists. The subtleties in the definition of the three categories of nonuse values reflect advanced thinking in the development of the nonuse value concept. Quantification of the magnitude of the value of nonuse benefits is the empirical challenge. There are strong arguments for and against the economists' ability to accurately quantify nonuse benefits.

Thus, it is recommended that the literature be reviewed with particular focus on quantification issues. Along with the theoretical challenges in quantification, special attention should be given to reviewing past examples of empirical quantification of nonuse benefits to better understand the possibilities and shortfalls encountered. This will lead to a better understanding of how, or if, nonuse values can be used in the Corps plan formulation process. A project such as this would require four to six months. The result would be a documented literature review and recommendations regarding the applicability of the various categories of nonuse values for Corps planners.

2. *Review the impact of Corps environmental policy on the selection of benefit categories for reporting purposes*.

As Corps policy is evolving, the means for justifying project proposals from the field perspective has become less clear. Review of Corps feasibility reports indicates certain benefit categories pursued for one proposal, but different categories in another. What is not clear from the field perspective is which benefit categories are most meaningful to meet the Corps policy and to eventually be approved for construction. Policies and positions related to cost-sharing rules and budget priorities all enter the picture.

A review and analysis of the related policies and their respective preference toward certain environmental benefit categories would be examined. This six-month study would produce a general assessment of benefit categories most appropriate to present Corps environmental policy and authorizations.

3. *Clarify the roles of surrogate market and nonmarket valuation techniques in estimating project benefits*.

While many surrogate market and nonmarket techniques have been developed in the literature, their actual application has revealed empirical shortfalls. Contingent valuation is a recognized technique in measuring recreation benefits at Corps projects. CERCLA suggests the method is an appropriate means for measuring environmental damage from hazardous waste. Many profess contingent valuation as essentially the only way to quantify nonuse benefits and probably the most accurate way to understand use benefits. Contingent valuation is a method that continues to be debated among professional economists. There are very real methodological constraints that cause practitioners to use the method cautiously. A focus on what contingent valuation has to offer the Corps planner in the plan formulation process should be carried out through literature review. Similarly, for NED analysis the appropriateness of hedonic pricing might be questioned in agricultural areas where land prices are significantly impacted by farm subsidy programs. The travel cost method also has both analytical and conceptual constraints that should be considered.

This research would be a literature review and discussion of the possibilities of using surrogate market and nonmarket techniques in the context of USACE planning and would be an estimated six month effort. Examples of accepted applications of the method, especially pertinent to environmental projects, would be summarized. Recommendations for appropriate application of these methodologies to the Corps planning process would be made.

4. *Examine stakeholders perceptions of the environment.*

Underlying many of the issues concerning stakeholder participation is the fact that relatively little is known about how lay persons contemplate and mentally represent environmental resources. The fact is, most people really do not think about environmental issues very often. Contemplation occurs most frequently when a resource near them is damaged or threatened in some way. If the Corps is to communicate effectively with stakeholders, it should invest in research that characterizes how stakeholders' mental models of a functioning environment differ from scientific and management models. Corps planners then will be better equipped to anticipate unique values regarding the function and product of environmental restoration and mitigation projects.

A review of the literature regarding mental maps of environmental processes should be conducted. A general model should be formulated, and recommendations for further developing the mental map concept should be made. An enhanced understanding of these thought processes may also lead to advances in questionnaire structure and content for contingent valuation efforts.

5. *Develop a summary of "look up" NED environmental benefit estimates for use in incremental justification.*

The Corps should research the feasibility and utility of "look up" use and nonuse environmental benefit estimates. Estimates of the value of restoration services from a related project alternative or feature may be of use to help justify incremental cost. Corps planners would need to establish that the benefit estimates are professionally credible and that estimates are for services similar to those being provided by the considered alternative.

In line with the concept of the compilation of benefit values is the development of an accounting system to track the benefits actually realized at projects after completion. This would allow for subsequent use of these data in future plan formulation situations. In most cases, post-construction surveys and monitoring are absent from the operation activities. An active monitoring program reminiscent to the data collection activities in the Corps' environmental management program on the Upper Mississippi would support benefit assessment needs.

The product provided under this recommendation would provide a discussion of the strength and limitations of such a benefit "look up" table. A framework for development of the table and servicing through literature values and post-project monitoring would be offered. This would require approximately ten months for a team consisting of a principal investigator, senior analyst, and research associate.

6. *Coordinate monetary and other valuation research efforts and application experience with other Federal agencies*.

It is imperative that the Corps coordinate research on monetary and other valuation with other Federal resource agencies. This coordination should produce two-way communication with other agencies. The research and application efforts of the Federal resource agencies currently include a wide diversity of techniques and applications (see Chapter III). These research programs include efforts focused upon both monetary valuation and nonmonetary evaluation, especially notable are the progressive efforts being undertaken at NOAA, DOE, and EPA.

It appears that many of the research advancements made within Federal agencies stay within their respective jurisdictions, resulting in limited cross fertilization and potential duplication of effort. There are many avenues for coordinating the research and application of monetary and other valuation techniques. These range from informal to formal and include workshops and conferences, interagency committees, informal contacts, and monitoring Federal publications. Of these options a workshop or conference dedicated to environmental evaluation measures would probably be most fruitful, since it could involve formal papers and informal mixing of participants.

Thus, it is recommended that a workshop involving the major resource agencies take place with focus on present environmental evaluation activities and research. Selected representation from the academic community would be invited to participate in the workshop. The goal of the workshop would be to identify research goals of the major agencies and promote appropriate coordination among the respective research agendas. The planning and coordination of this workshop, assuming the number of attendees would be approximately 30, would require approximately three to four months effort. Documentation of the workshop activities and results would require an additional one month effort.

Methods Development

7. *Develop decision processes for large versus small project planning procedures*.

The size and scale of a project dictate the amount of planning investment, though this appears to be inconsistently applied across the Corps. Certainly, the planning budget for a project controls the level of detail dedicated to assessing project benefits (both monetary and other). Flexibility in applying the restoration planning steps is essential to accommodate differences in project scale. Conducting a feasibility study for a small project constitutes a significant amount of the total cost, in some cases exceeding the construction costs. The Corps should invest significant one-time resources in the development of a classification model for small projects, in which each classification has an associated dollar-value threshold. Such a model could direct the measurement of only a small set of relatively inexpensive variables at each site to be evaluated.

Decision processes that more effectively prioritize potentially large Corps projects should include an initial screening phase based on analytical review of potential projects, field assessments of the feasibility of stakeholder participation and cooperation for projects in the reduced set, and final prioritization based on the combined input of scientific, economic, and management models.

This research would involve a survey of actual planning practices overlaid on the Corps' six-step planning process. Segments of this process where scale becomes an issue would be identified and recommendations for scale-sensitive approaches would be made. The resultant product would be an offering of two (or more) renditions of the six-step planning process based upon project size. This is estimated to be a nine to twelve month study.

8. *Develop watershed-based methods for conducting environmental evaluation*.

Mitigation and restoration methods should evaluate watershed best management practices when examining alternatives. Benefits can be developed over a greater geographical area based on this approach and can also create alternatives that are more cost-effective than those formed on a site-specific basis. The product of this approach should be a vision that is shared by the players in the watershed. An excellent example of a thorough approach is the interagency report on the Kesterson Restoration Plan. The planning and restoration efforts in the Upper Mississippi also offer successes of the watershed approach.

Examples of effective watershed planning would be sought and analyzed. A framework for watershed planning, including definition of objective and goals, and restoration prioritization would be included. Overlaying this process would be a focus on factors toward effective coordination between interested parties. This would involve review of project documentation, interviews, and site visits. Estimated time for this project is 12 to 15 months.

Demonstration Case Studies

9. *Perform demonstration case studies of small and large projects focusing on appropriate benefit categories based on project/program authorities.*

Planners are faced with trying to interpret evolving guidance, changing policy, and limited technical support in developing project plans. Previous research recommendations specify literature review and tool development, but it is important that these advancements be done in concert with real planning situations. This will help insure properly designed tools. Given a well-defined "self-study" plan, the preliminary models of scaling guidance and standard benefit applications could be tested and refined. This would first require a willing study manager at a Corps district.

The product of this recommendation would be a report documenting the application of small versus large and standard benefit category models proposed above. This effort would also serve a portion of the realtime plan formulation needs of the participating district. The time required on this effort would be somewhat a function of the size and extent of the planning efforts. The estimate for time is 24 months for multi-member research team. Researchers would conduct extended on-site investigations at the participating site.

RECOMMENDATIONS FOR OTHER EEIRP WORK UNITS

10. *Enhanced opportunities for formal trade-off analysis, multi-attribute analysis, arbitration and negotiation techniques in environmental plan formulation.*

If some groups are not represented at the negotiation, then negotiated restoration decisions may be neither "equitable" (despite the making of compensation payments) or effective in reaching agreements that will lead to implementation. For example, a negotiated decision for an alternative to increase the salmon runs on the Columbia River that does not include native American interests might not yield an equitable decision or be implementable. The prerequisite to effectively serve any negotiations or group consensus on an environmental project is to identify and assemble the major stakeholders within the project. This process should be examined and documented through a literature search.

There are two cornerstones of this approach: (1) sound technical and scientific analyses of environmental functions and structures as inputs to the process, and (2) decision-making and negotiation protocols for reaching solutions jointly with stakeholders. Negotiation may well be a more practical alternative than quantification for difficult-to-measure factors such as nonuse values.

Another approach to consider from the literature is multiattribute utility analysis (MAU). This approach offers respondents tools for thinking about uncertain values (e.g., value of wetlands) in addition to the provision of policy and/or management information. Such procedures enable shareholders to explicitly confront tradeoffs between various problem dimensions such as environmental features.

This project would be a report consisting of a literature review supported with an annotated bibliography. This synthesized information could be used by the Corps to develop different project-oriented support tools for negotiation-based decision-making. This literature search and report would require approximately twelve months of development time.

11. *Develop computer-based gaming and simulation tools for trade-off analysis*.

Part of the difficulty in developing appropriate benefit categories is getting a mutual agreement from all the players involved. These difficulties arise due to differences in agency mission and varying perceptions of project benefits by the public. Accommodating these views can be challenging, especially if Corps planners are not trained to facilitate trade-off negotiations.

The Corps should develop computer-based gaming and simulation tools to facilitate the understanding of trade-offs by stakeholders in negotiated decision making. The information to complete this task would be gathered as part of Literature and Practice Search.

The gaming and simulation tools will provide opportunities for planners to develop trade-off skills that are associated with the environmental planning process, especially when dealing with multiple stakeholders. This effort would require off-the-shelf or customized model development and computer software design. Estimated time on the proposed project is 12 months, followed by a 6 to 9 month case study validation.

12. *Continue developing incremental analysis framework with focus on expansion of capabilities*.

Incremental cost analysis is presently being used in the Corps to examine the incremental benefits of restoration alternatives, typically in terms of dollars per habitat-unit. Continued application and testing of the incremental cost framework will aid in refinement of the techniques and procedures. Publishing the applications in planning guidance and training materials will also educate the incremental analysis users.

The incremental analysis framework is also well-suited to evaluate decisions involving negotiations among decision makers. Interested parties may be motivated by wealth effects or by ideological concerns about the preferences people ought to hold for the environment, and decision makers have used incremental cost information in negotiations about the "values" from restoration alternatives. Thus, the incremental analysis framework could potentially be developed as a means of negotiation.

Utilizing the incremental cost framework, "values" would be derived in a demonstration setting. The product would be full documentation of the approach and the results of the application. Recommendations would be made to refine/improve the technique. Estimated time to complete this effort is 8 to 10 months.

13. *Determine the ecological history of proposed project sites*.

Ecological history describes the biological, physical and chemical history of a project or projects, and shows what happened to cause the existing conditions. Much of the history is dependent on qualitative data. A story approach puts the other evaluation criteria in context and captures elements of projects that are absent from existing analytic tools. This would serve Corps planning needs in defining planning objectives and alternatives that will work in the ecological context of the watershed. The planner would learn what relevant content items should be included and how to conclude with a clear pronouncement of potential benefits.

The product of this recommendation would be a report that would serve the selection process of an on-going project. This document would also serve as a framework for analysis of the ecological history approach and how it interfaces with the traditional plan formulation approaches used in the Corps. The approximate time required for this project is 12 months.

14. *Test negotiation arrangements at project level and combine and compare with benefit quantification*.

Demonstration of selected negotiation techniques on an actual project would serve to refine the technique and judge its worth for further application. Parallel examination of the decisions made under this framework, compared to traditional approach through quantifying benefits, would serve both as a check and provide insights to improving the design.

Project features and desired benefits would be identified using negotiation techniques. The product would provide full documentation of the approach and the results of the application. Recommendations would be made to refine/improve the technique. This effort is somewhat open-ended, but to fully test these techniques a two-year effort would probably be required. Careful selection of test sites would be needed to ensure full cooperation of Corps and other personnel involved.

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APPENDIX A
CONCEPTUALLY SOUND AND OPERATIONAL METHODS FOR ENVIRONMENTAL VALUATION

James P. Heaney

CONCEPTUALLY SOUND AND OPERATIONAL METHODS FOR ENVIRONMENTAL VALUATION

INTRODUCTION

The purpose of this paper is to describe how environmental benefits can be quantified within the context of the current 1983 Principles and Guidelines used by federal water resources agencies to do benefit-cost analysis. The relevant concepts are reviewed and selected results are presented of an earlier effort to develop such guidelines for the St. Johns River Water Management District in Florida (Heaney et al. 1989, Heaney et al. 1991). The interested reader is referred to these two reports for the details of the development of the theory and the extensive case study applications. In addition to summarizing this directly related work, an analysis on how to develop such an environmental valuation methodology is presented. The opinion of this author on this subject has been influenced by participation in an on-going review of Corps of Engineers environmental restoration studies. Also, recent renewed interest in both benefit-cost analysis (U.S. Advisory Commission on Intergovernmental Relations 1993) and better integration of environmental values (Interagency Floodplain Management Review Committee 1994) have generated additional enthusiasm for pursuing these topics.

The balance of this paper is divided into summary discussion regarding the availability of general guidelines for doing benefit-cost analysis including environmental valuation. Then, the Florida case studies are presented. The importance of databases for benefit-cost analysis is stressed. Furthermore, the proposed property valuation approach is described wherein "property" includes lakes, rivers, estuaries, and wetlands. Last, the summary and conclusions are presented.

ADEQUACY OF PRINCIPLES AND GUIDELINES CONCEPTS

The use of benefit-cost analysis techniques for evaluating federal water projects began in 1936. The first interagency guidelines were published in 1950 and have been updated several times. In the 1970s, environmental and social impacts, multiple objective analysis, and risk analysis were added as components of the evaluation process. The 1983 Principles and Guidelines (P&G) revised the procedure to again focus on National Economic Development (NED) as the primary objective (U.S. Water Resources Council 1983). The general theory and numerous applications of benefit-cost analysis are well documented. Schmid (1989) presents a comprehensive review of the field. In addition, the Institute for Water Resources of the Corps of Engineers has prepared more detailed interpretations of how to conduct specific types of benefit-cost analyses. The most recent P&G (1983) present specific instructions for the following categories of water resources:

No.	Category
1.	Municipal and industrial water supply benefits
2.	Agricultural floods, erosion, and sedimentation
3.	Agricultural drainage
4.	Agricultural irrigation
5.	Urban flood damage reduction
6.	Hydropower
7.	Navigation
8.	Recreation
9.	Commercial fishing
10.	Environmental quality

The Environmental Protection Agency is not covered by the Principles and Guidelines. However, for the Florida study, environmental quality was added as the tenth category.

GENERAL GUIDELINES FOR ENVIRONMENTAL IMPACT ASSESSMENT

Hufschmidt et al. (1983) classify benefit-cost valuation techniques for assessing effects on environmental quality as shown in Table 1. Their taxonomy partitions valuation techniques into market oriented and service oriented. Examples of applications to producer goods and services and consumer goods and services are included. Ortolano (1984) summarizes the environmental impact methodology using the materials budget approach espoused by Resources for the Future (Kneese and Bower 1979).

They list six ways of controlling unwanted residuals from economic activities.

1. Treat the residual.
2. Reduce the level of output.
3. Produce the same outputs using less damaging production processes.
4. Produce the same outputs using less damaging inputs.
5. Produce different outputs and thereby generate less damaging residuals.
6. Increase materials recovery and reuse, i.e., recycling.

These six methods can be cross-referenced with Table 1.

Heaney (1988) reviewed 20 years of efforts to define the benefits of urban stormwater quality management. He concluded that it is essential to quantify impacts in terms of benefit-cost analysis. It is difficult, if not impossible, to develop meaningful measures of ill-defined concepts, such as ecosystem health or fishable and swimmable waters.

The concepts from environmental economics are clear. The technological externalities associated with productive activities should be incorporated into benefit-cost calculations. Ideally, these impacts should be internalized so as to not cause detrimental off-site impacts using one or more of the six options listed above. Numerous applications of these principles have

TABLE A-1
CLASSIFICATION OF COST AND BENEFIT VALUATION TECHNIQUES FOR ASSESSING EFFECTS ON ENVIRONMENTAL QUALITY

Valuation Technique	Examples of Application	
	Producer Goods and Services	**Consumer Goods and Services**
Market Oriented		
1. Benefit valuation using actual market prices of productive goods and services		
(a) Changes in value of output	Loss of value of agricultural crops caused by higher salinity	
(b) Loss of earnings	Value of productive services lost through increased illness and death caused by air pollution	
2. Cost valuation using actual market prices of environmental protection inputs		
(a) Preventive expenditures	Cost of environmental safeguards in project design	Cost of noise insulation: Cost of intake water treatment
(b) Replacement cost	Cost of replacing structures damaged by acid rain	Cost of additional painting of houses damaged by air pollution
(c) Shadow project	Cost of restoring commercial fresh-water fisheries damaged by discharge	Cost of supplying alternative recreational facilities destroyed by development project
(d) Cost-effectiveness analysis	Cost of alternative means of disposing of wastewater from a geothermal energy project	
3. Benefit evaluation using surrogate markets		
(a) Marketed goods as environmental surrogates	Cost of sewage treatment processes as proxy for water purification by ecosystems	Price paid for visits to private parks & entertainment as proxy for value of visits to wilderness area
(b) Property value approach	Changes in commercial property values as a result of water pollution	Changes in residential property values as a result of air pollution
(c) Other land value approaches		Prices paid by government for land reserved for national parks
(d) Travel Cost		Valuation of recreational benefits of a public park
(e) Wage differential approach		Estimation of the willingness of workers to trade off wages for improvement
(f) Acceptance of compensation	Compensation for damage to crops	Compensation for adverse health effects
Survey Oriented (hypothetical valuation)		
1. Direct questioning of willingness to pay		
(a) Bidding games		Estimate of willingness to pay for access to an urban park
2. Direct questioning of choices of quantities		
(a) Costless choice method		Hypothetical application to air pollution

Reference. Hufschmidt et al. (1983)

been made in the water resources field. For example, new urban flood control and drainage systems must be designed so as to not increase the peak rate of discharge or the volume of discharge beyond what occurred prior to development. Also, on-site detention systems should provide adequate treatment of the urban runoff so as to not degrade downstream water quality.

Thus, the general concepts of benefit-cost analysis, including environmental economics, appear to provide adequate guidelines for how to properly account for environmental impacts. However, the application of these concepts has not been consistent in the water resources field. Many of the existing projects were evaluated and constructed prior to the 1960s and 1970s when the key environmental economics principles were articulated. However, we still see major problems in incorporating these principles in contemporary benefit-cost analysis for reasons to be discussed in the following sections.

The next section summarizes the results of a three year effort to develop a more complete and consistent methodology for doing benefit-cost analysis that incorporates environmental impacts. The research was done for the St. Johns River Water Management District (SJRWMD) who was seeking a better way to prioritize its watershed management activities. A significant part of the SJRWMD contains Corps of Engineers projects built prior to 1970.

FLORIDA CASE STUDIES

The purpose of this section is to present an overview of a three year effort, conducted from 1988 to 1991, to develop a benefit-cost methodology suitable for a regional water management agency in northeast Florida (Heaney et al. 1989 and Heaney et al. 1991). The history of the development of the Corps of Engineers project in this area and the current water control manual are presented in Vearil (1991). The St. Johns River Water Management District (SJRWMD) wanted a benefit-cost methodology developed to assist it in evaluating alternative water resources planning and operations proposals. The SJRWMD is the operating agency for several Corps of Engineers projects located in its region. A map of the SJRWMD is shown in Figure 1. Thus, we had the benefit of being able to review earlier benefit-cost estimates for some components of the case study. However, in this study, we were not constrained to follow the P&G, but rather were able to use the P&G to the extent we felt it was an appropriate guideline. Environmental valuation was a very important part of the study because of on-going environmental restoration and land acquisition programs.

The study area for the Florida socio-economic analysis is the Upper Oklawaha River Basin located in central Florida as shown in sub-basins 1, 2, and 3 of Figure 1. The focal point of the initial study (Heaney et al. 1989) was the environmental impact of the muck farming activities at the north end of Lake Apopka on the lake itself and on downstream water quality. The muck farms were created by placing a levee across the north end of Lake Apopka in order to permit farming of the rich muck soil as shown in Figure 2. After many unsuccessful efforts to protect this low lying muck land, an adequate system was finally installed in the early 1940s. While the agricultural productivity of the muck farms is quite high, the environmental costs to Lake Apopka have also been high. Within a few years of pumping large amounts of agricultural drainage water into Lake Apopka, it became eutrophic and its recreational use declined

Figure A-1 (Map of the Oklahawa River Basin and Boundaries of the Upper St. John's River Water Management District) Could Not Be Reproduced Electronically.

Figure A-2 (Illustration of Hypothetical Conditions at Lake Apopka Muck Farms, and Typical Farming Areas) Could Not Be Reproduced Electronically.

precipitously. Lake Apopka is now the subject of a $50 million cleanup sponsored by the State of Florida. The Lake Apopka case study is a smaller version of a similar project in south Florida wherein over 600,000 acres of agricultural land was drained by constructing a dike along the south end of Lake Okeechobee. The backpumping of this drainage water into Lake Okeechobee is a threat to the primary water supply source for south Florida and the discharge of drainage water to the south poses a threat to the Everglades.

During the second phase of the study, we looked at the downstream lakes in the Upper Oklawaha chain with particular emphasis on Lakes Harris and Griffin (Heaney et al. 1991). This study area is part of the Corps of Engineers Four River Basin project (Vearil 1991). Detailed recreation benefit evaluations were performed. We also looked at the expected benefits from public acquisition of thirteen candidate parcels of land in the Upper Oklawaha Basin as shown in Figure 3. This evaluation was done in cooperation with the land acquisition group at the SJRWMD. They had independently developed their own method for prioritizing land acquisition. Finally, we analyzed two adjacent lakes located about 50 miles north of the Upper Oklawaha Chain. Lakes Brooklyn and Santa Fe illustrated the importance of lake level fluctuation on land values.

Results from these case studies are presented below within the context of developing methods for overall environmental valuation.

DATABASES FOR BENEFIT-COST ANALYSIS

In the 58-year history of doing benefit-cost analysis, the primary emphasis has been to develop conceptually sound methodologies and normative models for water resources planning of new investments. Unfortunately, virtually no work has been done on retrospective evaluations of the actual realizations of benefits and costs. Without such feedback mechanisms, we do not have reliable databases for doing benefit-cost analysis. The primary focus of contemporary water management activities in the United States is on operations management. Consequently, we find ourselves ill-prepared to develop meaningful estimates of benefits based on the almost total lack of systematically developed databases over the past 58 years. The unfortunate result of the predilection with models and concepts is that benefit-cost information is viewed with great skepticism by other professionals due to its weak database. Indeed, the lack of attention to developing meaningful databases for doing benefit-cost analysis stands in stark contrast to other environmental sciences which develop reliable field data before postulating elaborate normative theories.

This lack of reliable socio-economic information became apparent early in our Florida studies (Heaney et al. 1989, Heaney et al. 1991). Fortunately, we discovered the availability of county and state tax assessor's information late in the effort. Tax assessors are responsible for valuing property for all use categories as the basis for assessing ad valorem taxes. Because of the importance of these estimates, standardized procedures have been developed. Of paramount importance is the fact that the database for doing these assessments is available and being updated continuously. For example, the State of Florida divides land uses into 100 categories. These 100 categories are further partitioned so that 459 sub-codes exist. The State of Florida Department of Revenue also has a standard method of calculating the value in use for all agricultural activities in the state. These crop income estimates are calibrated against land sales data to get reliable estimates of value in use. An example of this system is shown in Table 2. The effect of environmental influences can be estimated based on the expected value of various levels of land "improvements" which correlate directly with the extent of available irrigation water and adequate drainage.

Figure A-3 (Location of Properties Being Considered for Acquisition) Could Not Be Reproduced Electronically.

TABLE A-2
EXAMPLE OF STATE OF FLORIDA CROP DATABASE

				Costs, $/acre Manage			Trees/acre = 116 Service life = 30						
							Net Income Due To		Capitalization Rate		Value Per Acre		
Effective Age, Yr.	Yield Boxes/ Acre	Price $/Box	Gross Income, $	5% of Gross	Production Cost	Net Income	Land	Trees	Land	Trees	Land	Trees	Total
4	151	6.30	951	48	667	237	153	84	0.1277	0.1661	1198	504	1702
6	180	6.30	1134	57	667	410	153	257	0.1277	0.1693	1198	1520	2718
8	209	6.30	1317	66	667	584	153	431	0.1277	0.1731	1198	2489	3687
10	238	6.30	1499	75	667	757	153	604	0.1277	0.1777	1198	3401	4600
12	273	6.30	1720	86	667	967	153	814	0.1277	0.1832	1198	4443	5641
14	307	6.30	1934	97	667	1170	153	1017	0.1277	0.1902	1198	5349	6547
16	342	6.30	2155	108	667	1380	153	1227	0.1277	0.1991	1198	6162	7360
18	383	6.30	2413	121	667	1625	153	1472	0.1277	0.2110	1198	6978	8176
20	429	6.30	2703	135	667	1901	153	1748	0.1277	0.2277	1198	7675	8873
22	464	6.30	2923	146	667	2110	153	1957	0.1277	0.2527	1198	7745	8943
24	464	6.30	2923	146	667	2110	153	1957	0.1277	0.2943	1198	6650	7848
26	464	6.30	2923	146	667	2110	153	1957	0.1277	0.3777	1198	5181	6380
28	464	6.30	2923	146	667	2110	153	1957	0.1277	0.6277	1198	3118	4316
29	464	6.30	2923	146	667	2110	153	1957	0.1277	1.1277	1198	1735	2934

Reference. State of Florida Dept. of Revenue, 1991.
(Heaney et al. 1991)

TABLE A-2 (Continued)
EXAMPLE OF STATE OF FLORIDA CROP DATABASE

Example 2. Pastureland Schedule -- Central/Southern

		Animal Unit Months		Acres/Animal									
Type	**Quality**	**Range**	**Typical Value**	**Range**	**Typical Value**	**Market lbs/acre**	**Price $/lb**	**Gross Income, $**	**Operating Expenses, $**	**Management, 5% of gross Income, $**	**Net Income, $**	**Capitalize Rate**	**Land Value, $**
Improved	Poor	<=6	6	--	--	153	0.611	93.48	68	4.67	20.81	0.1275	163.21
	Average	7-9	8	--	--	204	0.611	124.64	91	6.23	27.41	0.1275	214.99
	Good	10-12	10	--	--	255	0.611	155.81	108	7.79	40.01	0.1275	313.84
	Excellent	>12	13	--	--	331	0.611	202.24	125	10.11	67.13	0.1275	526.50
Semi-Improved	Poor	--	--	>=5	5	56	0.611	34.22	22.1	1.71	10.41	0.1275	81.61
	Good	--	--	3-4	3.5	79	0.611	48.27	31.2	2.41	14.66	0.1275	114.95
	Excellent	--	--	<3	2.7	103	0.611	62.93	40.4	3.15	19.39	0.1275	152.05
Native/ range	Poor	--	--	>15	15	14.8	0.611	9.04	4.2	0.45	4.39	0.1275	34.44
	Good	--	--	9-14	12	18.5	0.611	11.30	5.2	0.57	5.54	0.1275	43.44
	Excellent	--	--	<=8	7	31.5	0.611	19.25	8.9	0.96	9.38	0.1275	73.60

PROPERTY VALUE AS CAPITALIZED EQUIVALENT OF FUTURE EARNINGS

The effect of environmental enhancement or degradation on property values has been studied by numerous researchers for air and water management systems. A major advantage of using property values as a measure of environmental quality is that databases are available through property transactions as discussed above. Economists refer to this approach as hedonic valuation.

Freeman (1979) provides an excellent summary of efforts to relate urban property values to air quality. The general conclusion of nearly all of these studies was that air quality is capitalized in property values but empirical relationships varied greatly as did the actual variables included in the studies. Tobin and Newton (1986) examined the impact of flood hazard on property values. The magnitude and frequency of flooding along with the socio-economic characteristics of the residents in the floodplain were found to affect the rate of recovery of land values following a flood event. Heaney et al. (1989, 1991) used a more process-oriented approach coupled with hydrologic and water quality models to estimate the impact of environmental quality on property values. The results of this effort and associated case studies are presented below:

Real estate appraisers estimate market value which can be defined as (Boyce 1981):

> "The highest price in terms of money which a property will bring in a competitive and open market under all conditions requisite to a fair sale, to the buyer and seller each acting prudently, knowledgeably, and assuming the price is not affected by undue stimulus."

The present value of a series of future annual income is:

$$PV = I_1/(1+i) + I_2/(1+i)^2 + \ldots + I_n/(1+i)^n \tag{1}$$

where

PV	=	present value, $
I_t	=	annual earnings in year t
n	=	number of years
i	=	discount rate

If $I_1 = I_2 = \ldots = I_n$, then equation 1 can be expressed as:

$$PV = I\,[\,1 - (1+i)^{-n}\,]/i \tag{2}$$

As *n* tends to infinity, the present value becomes:

$$PVC = I / i \tag{3}$$

where

PVC	=	capitalized present value of an infinite stream of annual future benefits
I	=	expected annual earnings
i	=	discount rate

The present value, PVC, is called the capitalized value of the future income stream.

The value of the land is enhanced by provision of improved water management such as irrigation and drainage. However, if this development causes technological externalities and the land owner is responsible for mitigating these damages, then the net land capitalized land value is:

$$PVCN = (I - C) / i \tag{4}$$

where

PVCN	=	capitalized present value with externalities internalized
C	=	internalized control costs to mitigate the external effects

For example, a detailed investigation of the rate of return for the muck farms north of Lake Apopka revealed an expected annual return of about $460 per acre (Heaney et al. 1989). Using a discount rate of 10 percent, the expected value of this land would be $4,600 per acre. Detailed studies of comparable muck land indicated an average selling price of $4,500 per acre, very close to farm budget estimate. The data requirements for the farm budget analysis are very high. Thus, the land sales estimates are the preferred way to make these estimates. For the case of Lake Apopka, the estimated cleanup costs are $50,000,000. The equivalent annual cost is about $5,000,000 per year. If the owners of the 14,000 acres of muck land had to pay this cost, then their control cost, C, would be about $360 per acre per year. Then, the expected value of this land would be reduced to about $1,000. The unresolved policy issue for Lake Apopka, the Everglades Agricultural Area, and for other agricultural areas is twofold: what level of control is needed, and who should pay this cost? For Florida conditions, about 5-15 percent of the land needs to be set aside to serve as equalizing storage and to provide water quality control on-site in order to internalize this problem. Depending on how the public policy debate turns out, the land values will range from unaffected to greatly reduced.

Detailed estimates were made of the loss in recreation value due to a degraded Lake Apopka (Heaney et al. 1989). The annual losses in recreation values were estimated to increase from $3.3 million per year in 1990 to $5.1 million per year by the year 2020. These losses are of the same magnitude as the present value of the farming activity near Lake Apopka. In this study, the relative economics are shifting in favor of remediation due to the rapid increases in population in the area. A summary of the overall balance sheet for the decades from 1960 to 2020 is shown in Table 3. As the affected population increases from 321,000 in 1960 to nearly 1.3 million in the year 2020, the net benefits of the muck farm activity go from positive to negative by the late 1980s.

This Lake Apopka case study is representative of the large, unresolved problem of agricultural land development in the United States. A closed system approach, as recommended in the Kesterson case study of agricultural drainage problems in California, would be even more

TABLE A-3
SUMMARIES OF SOCIO-ECONOMIC GAINS AND LOSSES ASSOCIATED WITH LAKE APOPKA, 1860-2020

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		All Values in $1,000/yr. in 1989 $					
			Disbenefits				
Year	Population 1,000's	Benefits Muck Farms	Direct Recreation	General Public	Riparian Property	Total Disbenefits	Net Benefits
1960	321	6400	1136	802	203	2141	4259
1970	414	6400	1464	2068	203	3735	2665
1980	576	6400	2038	2879	203	5120	1280
1990	816	6400	3003	4080	203	7286	(886)
2000	1009	6400	3713	5045	203	8961	(2561)
2010	1135	6400	4177	5675	203	10055	(3655)
2020	1259	6400	4633	6295	203	11131	(4731)

(1) Census year
(2) Census and median projected population for Lake and Orange counties
(3) Estimated net revenue from farming based on ADAM model
(4) Net loss in boating and swimming recreation based on actual and potential use rates
(5) Net loss in value to general public based on their willingness to pay to restore Lake Apopka
(6) Net loss in waterfront property values due to degraded lake
(7) Sum of columns—(4) + (5) + (6)
(8) Column (3) - column (7)

restrictive and expensive (San Joaquin Valley Drainage Program 1990). The specific recommendations for the Kesterson case are:

- Source control. On-farm improvements in the application of irrigation water to reduce the source of deep percolation in order to reduce the quantity of drainage water.

- Drainage reuse. Reuse drainage water on progressively more salt-tolerant plants.

- Evaporation system. Store and evaporate drainage water after reuse on salt-tolerant crops.

- Land retirement. Cease irrigation of more problem prone areas.

- Ground water management.

- Discharge to San Joaquin River where water quality standards can be met.

Institutional change including tiered water pricing, improved scheduling, water transfers and marketing, and formation of regional drainage management organizations.

Land irrigation and drainage of wetlands for agriculture has been a major government policy for well over a century. However, if one internalizes the detrimental effects of these activities, then the economics can shift considerably. The relative merits of remedial actions need to be evaluated on a case-by-case basis. Referring to the Lake Apopka example, the economic value of the crops is high, but so are the detrimental impacts. In this study area, the affected lake is near a rapidly urbanizing area (Orlando) with changing attitudes towards environmental quality. The people have shown a demonstrated willingness to control this pollution problem.

The recommended method for valuing environmental impacts is to use the tax assessor's database coupled with hydrologic information on the extent of water management to estimate property value impacts. This will account for the benefits to riparian and nearby lands. The value of rivers, lakes, wetlands, and estuaries can be estimated as a function of the services provided by these water bodies. Detailed descriptions for lakes and wetlands are presented later in this paper. For example, the Florida Department of Revenue has 38 categories of pasture land productivity ranging from poor to excellent. Much of the variation in quality is due to water management. The expected value of this land as it is affected by water management of wet and dry conditions can be estimated using Figure 4. This method is completely compatible with the Corps of Engineers' risk assessment methodology (Greeley-Polhemus Group 1992). The extent of "improvements" can be related directly to the ability to control water levels. However, the more sophisticated water management systems reduce on-site surface and subsurface soil moisture storage. Thus, the amount of irrigation and drainage water increases as the land is "improved" causing increased off-site externalities.

The results of a survey of the sales prices of muck land in Florida, shown in Table 4, indicate that these land values range from a minimum of about $300 per acre for unimproved muckland to over $5,000 per acre for vegetable crops with sophisticated water management. The market sales approach is much easier to use than the farm income approach and is the recommended method for riparian and nearby lands. The next sections describe procedures for estimating an "equivalent" property value for lakes and wetlands based on the functions they perform.

LAKE VALUATION

The value of lakes can be determined in the same manner as described above for normal land uses by viewing the lake as a "land use" whose value can be estimated based on its ability to generate income and/or enhance nearby property values. The total economic value of a lake is its value added to nearby property plus its value for other purposes which has not been

Figure A-4 (Derivation of Stage-Damage Relationship) Could Not Be Reproduced Electronically.

TABLE A-4
SELECTED LAND SALES DATA FOR DRAINED AND UNMODIFIED WETLANDS IN FLORIDA

No.	County	Sale Date	Water Body	Acres	$/Acre	1990 $/Acre	Crop
1	Lake	Jun-87	L. Griffin	900	3000	3412	Vegetables
2	Lake	Jun-87	L. Griffin	750	3000	3412	Vegetables
3	Lake	Feb-88	L. Apopka	140	3929	4291	Vegetables
4	Lake	Aug-86	L. Apopka	78	4487	5289	Vegetables
5	Lake	Oct-88	L. Apopka	1563	3199	3494	Vegetables
6	Lake	Sep-89	L. Apopka	80	3500	3647	Vegetables
7	Orange	Jul-89	L. Apopka	400	4625	4819	Vegetables
8	Hernando	Nov-84	--	7244	244	303	None
9	Hernando	Apr-84	--	7960	251	312	None
10	W. Palm	Oct-81	L. Okeechobee	1244	3000	4264	Sugar
11	W. Palm	Mar-83	L. Okeechobee	1600	3093	4012	Lettuce
12	W. Palm	Jul-83	L. Okeechobee	2266	2207	2863	Sod
13	W. Palm	Nov-84	L. Okeechobee	1830	3000	3731	Sugar
14	W. Palm	Jun-85	L. Okeechobee	320	2820	3386	Sugar/Veg.
15	W. Palm	Dec-85	L. Okeechobee	46	3025	3632	Sugar
16	W. Palm	Apr-86	L. Okeechobee	360	2500	2947	Sugar
17	W. Palm	Apr-86	L. Okeechobee	2046	2800	3301	Sod
18	W. Palm	Mar-88	L. Okeechobee	300	2600	2840	Sugar
19	W. Palm	Apr-88	L. Okeechobee	326	2436	2660	Sugar

Summary

Lake	n	$/Acre		
		Mean	Minimum	Maximum
Okeechobee	10	3364	2660	4264
Apopka	5	4308	3494	5289
Griffin	2	3412	3412	3412
Undrained	2	308	303	312

Consumer Price Index

Year	Value	Year	Value
81	90.9	82	96.5
83	99.6	84	103.9
85	107.6	86	109.6
87	113.6	88	118.3
89	124.0	90	129.2

capitalized in the water-related property values. Khatri-Chhetri and Hite (1990) summarize previous efforts to evaluate the various factors that influence lake waterfront property values. These studies have typically relied on developing regression models based on data for a cross-section of lakes. A major limitation is that no standardized databases are available. Our approach has been to interview county tax assessors and to obtain from them estimates of waterfront property values per front foot and then to combine this information with our lake water quality trophic state index (TSI) and hydrologic information. The TSI is a standard tool used in Florida (Huber et al. 1982, Hand et al. 1990). The results of detailed recreation use studies of five lakes in the Oklawaha chain are shown below:

Activity	Annual $/Acre of Lake
Sport fishing	$100
Beaches	15
Boating	55
Canoeing	9
Total	$179

General criteria for water-based recreation in rivers and lakes are shown below (National Ecology Research Center 1990):

	Depth in Feet	
Activity	Minimum	Maximum
Canoeing-river	0.5	1.5
Water skiing	5	9
Sailing3	5	
Boating-high power	3	4
Swimming	3	4

These constraints can be combined with stage-area relationships for a water body to estimate its overall recreational value, given its water quality.

Adjustments Due to Lake Level Fluctuations

This section describes how values can be adjusted based on the extent of fluctuations in lakes. Two lakes in north Florida were studied as the basis for this method: Lake Brooklyn, which fluctuates over 20 feet, and nearby Lake Santa Fe, which fluctuates 5.5 feet. From the point of view of economic impacts, the most important measure is not the range of elevations but rather the range of surface areas. The effect of the recent drought in Florida on the level of Lake Brooklyn is dramatic as shown in Figure 5. During recent years, the lake has gone from full to 23 percent of its original surface area. This loss of surface area has had a major impact on lakefront property values based on a sample of 67 land sales from February 1981 to January 1991. The estimated sales price for waterfront property on Lake Brooklyn is $240 per front foot. By comparison, the average sales price per front foot for nearby stable Lake Santa Fe is $904 per front foot. Under worst case conditions, Lake Santa Fe is still 96 percent of its original area. Both lakes have excellent water quality.

Figure A-5 (Change in Area as Level Declines for Lake Brooklyn) Could Not Be Reproduced Electronically.

Adjustments for Water Quality

The Trophic State Index (TSI) has evolved as the accepted single measure of water quality of lakes in Florida (Hand et al. 1990). According to the Florida Department of Environmental Regulation, the TSI for lakes can be placed in the following categories:

TSI Range	Lake Quality
0-59	good
60-69	fair
70-100	poor

The TSI's for 573 Florida lakes indicate a range from nearly 0 to over 100 with a median TSI of about 50. The TSI and associated assumed impact on waterfront property values are shown in Table 5. Lakes Brooklyn and Santa Fe both have excellent water quality. However, Lakes Apopka (TSI = 86.8), Griffin (TSI = 76.5), and Harris (63.1) have seriously degraded water quality. The water quality of Lakes Griffin and Harris is affected by Lake Apopka drainage.

The total estimated value per acre of lake area for eight lakes in Florida that accounts for riparian and nonriparian values including the effects of water quality, extent of lake level

TABLE A-5
LAKE DATABASE FOR ESTIMATING THE IMPACT OF TSI ON BENEFITS

Number	Lake	County	Area Acres	TSI
1	Magnolia	Clay	201	21.7
2	Brooklyn	Clay	635	29.0
3	Kingsley	Clay	1,627	29.9
4	Geneva	Clay	1,746	30.6
5	Santa Fe	Alachua	5,299	44.9
6	Yale	Lake	4,930	55.7
7	Orange	Alachua	13,160	58.6
8	Harris	Lake	17,650	63.1
9	Newnans	Alachua	7,350	72.9
10	Griffin	Lake	10,660	76.5
11	Dora	Lake	4,437	81.4
12	Apopka	Lake	30,670	86.8

fluctuations, lake size, and developability of the perimeter are shown in Table 6 (Heaney et al. 1991). The results indicate that lake surface area as a land use generates an annual income of less than $24 per acre for polluted Lake Apopka to nearly $1,000 per acre for high quality Lake Santa Fe. Larger lakes with good water quality and stable lake levels generate higher income values than high value agriculture. These estimates of value are felt to be conservative because they exclude nonuser values. Water supply, flood control, and water quality control were not major purposes for these lakes.

WETLAND VALUATION

In the previous section, a lake is considered as a "land use" and values per acre are estimated for lakes of various sizes and of differing water quality. This same approach will be used for wetland valuation.

A large literature exists for valuing wetlands with a very wide range of values. For example, Table 7 lists floodplain natural and cultural values that can be used as a checklist for wetlands (U.S. Water Resources Council 1979). Shabman and Batie (1988) list three key principles that must be followed in establishing values for wetland functions:

1. The services provided by the wetland must be identified and then directly linked to the wetland.

2. The with-and-without principle must be used to estimate benefits.

3. The alternative cost method must represent the least costly way to provide "equivalent" service that would actually be implemented.

Farber and Costanza (1987) and Costanza, Farber and Maxwell (1989) present methods to value wetlands from an ecologist's perspective. The general feeling is that many of the wetland benefits are public and cannot be captured by the property owner. Thus, wetlands are undervalued in the property market.

Analysis of the wetlands land sales database for Florida, presented in Table 4, shows that the market value of wetlands ranges from about $300 per acre for undrained wetlands to over $5,000 per acre for wetlands with sophisticated water control (Heaney et al. 1991). Expected values of drained wetlands in urban areas would be of the order of $30,000 per acre or more. Thus, the economic incentives for wetland drainage are clear. The provision of water management permits a wetland to go from $300 without water control, to $3,000 per acre for agricultural water use, to $30,000 per acre for urban land use.

For the Florida case study, it was fortunate that the St. Johns River Water Management District has an active land acquisition program which has been prioritized based on the following five criteria:

1. Water management benefits;
2. Water supply benefits;

TABLE A-6
ESTIMATE OF VALUES FOR SELECTED CENTRAL FLORIDA LAKES

1	2	3	4	5	6	7	8	9	10	11	12	13	14
					Nonriparian Annual Income		Equivalent Annual Income of Enhanced Property Value						
								Potential Property		Estimated Property			
Lake	Acres	Amin/ Amax	TSI	TSI Factor	Potential $/Acre	Net $/Acre	P/Pcalc.	$/front ft.	$/Acre	$/front ft.	$/Acre	Annualized Property Value, $/Acre	Total Annual Income $/Acre
Yale	4030	0.9	40	0.92	77.30	63.77	0.8	862.00	10050	569	6633	663.32	727.09
Dora	4437	0.9	84	0.30	81.19	21.92	1	887.00	9856	240	2661	266.12	288.04
Eustia	7806	0.9	65	0.66	113.32	66.93	1	966.00	8087	570	4777	477.66	544.59
Griffin	10660	0.9	70	0.56	0.00	0.00	0.8	1000.00	7166	405	2902	290.22	290.22
Harris	17650	0.9	61	0.73	0.00	0.00	1	1000.00	5569	658	3665	366.51	366.51
Apopka	30630	0.9	89	0.21	0.00	0.00	0.3	1000.00	4227	56	235	23.54	23.54
Brooklyn	635	0.23	30	1.00	35.26	8.11	2.	547.03	16061	252	7388	738.81	746.92
Santa Fe	5299	0.96	40	0.92	89.41	78.68	1.1	927.00	9418	897	9117	911.70	990.37

Column	Description
1	Lake name
2	Area when lake is at its normal full elevation
3	Stability factor, STABF, i.e., ratio at minimum stage to A(min) to maximum stage, Amax, or STABF = Amin/Amax
4	Tropic state Index of water quality. (Hand et al. 1990)
5	Water quality factor (WQF) as a function of TSI. (See Table 6.29)

TSI	**WQF**
< = 30	WQF = 1
30 < TSI < = 60	WQF = 1 - .25 * (TSI - 30)/30
60 < TSI < = 100	WQF = .75 - .75 * (TSI - 60)/40

Column	Description
6	Potential annual income per acre from nonwaterfront users.

Acres	**Income, $/Year**
< = 100	Inr = 81.95
100 - 1000	Inr = 16 + 32.4 * (A - 100)/900
1000 - 10000	Inr = 48.4 + 85.85 * (A - 1000)/9000
> = 10000	Inr = 134.25

Column	Description
7	Estimated annual income, il = lp * STABF * WQF (See Equation 6.7)
8	Perimeter factor, i.e., ratio of developable lake perimeter (P) to calculated perimeter, P (calc), assuming lake is circular, i.e., PERIMF = P/P(calc)
9	Potential waterfront property value, v. (See Table 6.31)

Area Range		
Min	Max	v(max), $/front foot
0	100	v(max) = 3.58 * A
100	1000	v(max) = 358 + 318 * (A-100)/900
1000	5000	v(max) = 676 + 246 * (A-1000)/4000
5000	10000	v(max) = 922 + 78 * (A-5000)/5000
10000	Infinity	v(max) = 1000

Column	Description
10	Potential property value, $/acre, = Vmax = v(max) * (4*43560*pi/A)^.5
11	Estimated property value, $/front foot v = v(max) * WQF * STABF * PERIMF
12	Estimated property value, $/acre V = Vmax * [v/v(max)]
13	Estimated annual income, from riparians, $/acre, Ir = V * i where i = capitalization rate, = .10
14	Total estimated annual income, $/acre, = I = Inr + Ir

TABLE A-7
LIST OF FLOODPLAIN NATURAL AND CULTURAL VALUES

I. Water Resources Values

- A. Natural Flood and Erosion Control
  - Reduce flood velocities
  - Reduce flood peaks
  - Reduce wind and wave impacts
  - Stabilize soils
- B. Water Quality Maintenance
  - Reduce sediment loads
  - Filter nutrients and impurities
  - Process organic and chemical wastes
  - Moderate temperature and water
  - Reduce sediment loads
- C. Maintain Groundwater Supply and Balance
  - Promote infiltration and aquifer recharge
  - Reduce frequency and duration of low flows
- D. Water Supply
  - Irrigation
  - Municipal
  - Industrial
  - Energy
- E. Navigation

II. Living Resources Values

- A. Support Flora
  - Maintain high biological productivity of floodplain and wetland
  - Maintain productivity of natural forests
  - Maintain natural crops
- B. Provide Fish and Wildlife Habitat
  - Maintain breeding and feeding grounds
  - Create and enhance waterfowl habitat
  - Protect habitat of rare and endangered species

III. Cultural Resource Values

- A. Maintain Harvest of Natural Products
  - Create and enhance agricultural lands
  - Provide areas for cultivation of fish and shellfish
  - Protect silvaculture
- B. Provide Recreation Opportunities
  - Provide areas for active and consumptive uses
  - Provide areas for passive activities
  - Provide open space values
  - Provide aesthetic values
- C. Provide Scientific Study and Outdoor Education Values
  - Provide opportunities for ecological studies
  - Provide historical and archeological sites

3. Water resource conservation and protection benefits;
4. Need for the project implementation; and
5. Cost to supply identified benefits.

To support this effort, a study was done on the suitability of candidate parcels using the following criteria:

1. Water quantity
2. Water quality
3. Fish/wildlife habitat
4. Recreation
5. Access
6. Restorability
7. Manageability
8. Availability

The use of the P&G was combined with the database provided by the St. Johns River Water Management District and this author's own concepts to evaluate the wetlands from a functional point of view. The results are presented below. A more detailed summary is contained in Heaney et al. (1991).

Water Supply Benefits

The concept of a water supply function is typically based on the premise that the wetland area serves as a recharge area for the groundwater supply. Additionally, it is necessary to show that, with the loss of this function, an alternative supply would be necessary. For this case study, the water supply benefits of these wetlands are not significant.

Flood Control

In general, wetlands store water during periods of high runoff. This storage has a routing effect on the runoff hydrograph, thereby reducing the magnitude of peak flows. A good example of the ability of wetlands to provide flood control is documented in the U.S. Army Corps of Engineers (1971) study of the Charles River Watershed in Massachusetts. This COE study states that, during an actual recorded flood event, the natural valley storage reduced the flood peak by 65 percent and lagged the peak outflow by about three days. Evaluating the loss of wetlands, the COE calculated the avoided flood damages to be $647,000 per year. A dramatic example of the effect of loss of wetlands and channelization on flood peaks is the Kissimmee River Basin where major wetland drainage occurred (Bedient, Huber, and Heaney 1977). The downstream flood peaks with and without the wetland drainage and channelization, shown in Figure 6, indicates how the flood hydrographs have gone from lower peaks and longer durations (1953-54 and 1960-61) to much higher peaks with shorter durations (1969-70). In this study, the effect of drainage was quantified in terms of drainage density as shown in Figure 7 wherein drainage density is seen to increase several fold as drainage occurs. This provides direct surface pathways for the stormwater and associated pollutants to reach the receiving water.

Figure A-6 (Effect of Channelization and Upland Drainage on Flood Hydrographs in the Lower Kissimmee River Basin) Could Not Be Reproduced Electronically.

A detailed flood analysis was done for the Oklawaha Chain with and without wetlands. The results indicate that restoration of the local wetlands would have only minor flood control benefits since the existing flood control system is adequate and downstream development is not significant.

On-site Stormwater Quality Management

The State of Florida has established regulations for agricultural discharges. The performance standards require that:

1. Discharges from the agricultural stormwater management system shall not cause or contribute to a violation of water quality standards in waters of the state.

Figure A-7 (Drainage Density and Land Use in the Kissimmee River Basin) Could Not Be Reproduced Electronically.

2. The stormwater management system shall be designed and operated to provide a level of treatment so that discharges will not contain more than 20 mg/l of biochemical oxygen demand and 20 mg/l of total suspended solids.

3. The stormwater management system shall be designed and operated to provide a level of treatment and pollutant reduction so that pollutant loads discharged to surface waters of the state from a particular agricultural operation are 80 percent less than those from a similar operation which did not incorporate a treatment system or water quality practices.

The prescribed water quality practices are:

1. Wet detention treatment volume is equal to the first inch of runoff.

2. The permanent pool volume provides an average residence time of 21 days during the wet season (June through October). This volume may be determined by estimating 13.82 percent of the wet season average runoff.
3. Pond depths below the water control elevation for new ponds should not exceed an average depth of four feet or a maximum depth of ten feet. Existing ponds should be altered to conform to pond depths not exceeding five feet over 70 percent of the pond area.

For this application, the agricultural simulation model developed by Heaney et al. (1989) can be used to size the detention system. The results of this calculation indicate an annual value of these stormwater quality management systems of $561 per acre with a range from $448 to $674 per acre.

Off-site Wastewater and Stormwater Treatment

The use of wetlands for wastewater treatment is well documented, e.g., Hammer 1989. The alternative cost method is used to value the wetlands for treatment purposes. As of 1991, no requirement existed for general stormwater quality control. Thus, no benefit is claimed for off-site stormwater treatment. The feasibility of wetlands for wastewater treatment depends on their proximity to the waste sources, receiving water quality requirements, and the nature of adjacent land areas. For this study area, the competitive alternative to wetlands is spray irrigation. For those areas where wetlands were favorably located, the estimated annual wetland benefits ranged from $233 per acre to $1,550 per acre with a mean of $893 per acre.

Recreation

In cases of wetlands riparian to the lakes, removal of the dikes causes these wetlands to become part of the lake. Analysis of the stage-area relationships for the affected lakes indicates the type of recreation that can be supported by the wetlands. A reasonable estimate was found to be the sum of sport fishing, canoeing, and one half of the boating values or a total annual recreation value of $1,620 per acre.

Water Management and Navigation

For these purposes, it could only be determined that the impact was positive, but the magnitude could not be estimated.

Summary of Wetland Values

This section has clearly demonstrated that it is possible to derive defensible estimates of wetland values based on their functions. The results for this case study are shown below:

Wetland Function	Present Value of Benefit, $/Acre
Water supply	$0
Flood control	5
Water quality	561
Stormwater control	+
Wastewater treatment	893
Recreation*	1,620
Water management/navigation	+

\+ Positive benefit is possible, but no value was determined.
* Value for Knight, Lowerie Brown, Eustis and Long Farms only.

These benefits are wetland specific. Also, the benefits are not necessarily additive. For example, a wetland used for wastewater treatment cannot provide the same level of service for recreation. These values represent a lower bound on the value of these wetlands. Nonuser benefits have not been included.

This case study illustrates that it is possible to develop defensible estimates of wetland values using a process oriented functional analysis of the services that they perform. The value of wetlands, as any other land use, can be expected to vary widely depending on the demand for these services. For example, for this case study, the wetlands had relatively little value for flood control storage whereas they have a major impact on flood storage for the nearby Kissimmee River Basin (Bedient, Huber, and Heaney 1977).

APPLICATIONS OF B-C ANALYSIS PRINCIPLES WITHIN FEDERAL AGENCIES

While the general methodology for benefit-cost analysis is well defined, its application by government agencies is sometimes restricted due to their limited missions and legislative mandates. Several illustrative examples developed from review of feasibility reports are presented below:

1. Under the U.S. Army Corps of Engineers 1135 Environmental Restoration program, restoration benefits are prescribed to be defined in terms of fish and wildlife habitat. Recreation benefits are often not included.

2. Benefit-cost analyses for irrigation projects often do not account for the degradation in water quality caused by leaching salts and other constituents such as selenium from

the soil, e.g., Kesterson Wildlife Refuge problem (San Joaquin Valley Drainage Program 1990).

3. Flood control projects using levees do not always account for the loss of wetlands, e.g., the review of the 1993 Great Flood (Heaney 1994).

4. Water supply reservoir construction often do not account for the impact of streamflow modifications on low flows in these downstream river.

5. Some flood control and drainage projects have not accounted for increased off-site water quality problems, i.e., stormwater pollution, e.g., Lake Apopka muck farms and the Everglades Agricultural Area discussed above.

6. Navigation projects sometimes do not consider all detrimental impacts of flow regulation on other uses of the river, e.g., the current debate on the impact of navigation on the Lower Missouri River system (Heaney 1994).

Thus, a major restructuring of the application of benefit-cost procedures would be needed to require a uniform application of these principles within and across federal water agencies. Interestingly, a recent high level interagency committee report recommends such action (U.S. Advisory Commission on Intergovernmental Relations 1993).

CONCLUSIONS ON ENVIRONMENTAL VALUATION

Benefit-cost analysis methods have been used by the federal government since 1936 and standardized guidelines have existed since 1950. These guidelines have continued to be refined with the latest version appearing in 1983. Also, the Institute of Water Resources of the Corps of Engineers has an active program of developing more detailed guidelines for each of the major functional areas in water resources. In general, there seems to be agreement on the P&G methods for assessing benefits and that suitable models are available.

The P&G, coupled with the mainstream literature on environmental economics, proved to be adequate conceptual guidance for developing a benefit-cost methodology for the St. Johns River Water Management District with emphasis on quantifying environmental benefits. The main gap in assessing environmental impacts is simply that the calculations have not been done even though the methods exist. Thus, existing projects have been justified by a calculus that ignores these significant disbenefits due to environmental degradation. Given that such calculations were omitted, what can be done? One option is to recalculate the benefits using this more complete procedure. This will provide a much more plausible basis for environmental remediation benefits than simply looking at fish and wildlife habitat.

An important reason why environmental benefit quantification seems so imbalanced is that the prescribed procedures vary from program to program even within a given agency. Two key omissions from existing methods that could provide much improved estimates of environmental values are:

1. Inconsistent use of available methods for assessing recreational benefits.

2. Not properly estimating disbenefits resulting from technological externalities caused by water projects even though the methods for doing so are straightforward.

Given the rapidly changing role of the stakeholders in water resources projects, it is important to explicitly quantify the incidence of these benefits. For example, EPA no longer provides direct federal support for controlling combined sewer overflows in urban areas. Thus, local stakeholders, who must pay some or all of the costs, are quite interested in how the benefits are distributed and to explore multipurpose opportunities.

While many papers and books are available on benefit-cost analysis, there is a dearth of good data available on rigorous attempts to quantify these environmental impacts. Some of the blame for this lack of data rests on the shoulders of the economics profession who place higher value on conceptual versus experimental studies. This is unfortunate since the conceptual models are excellent, but the quality of the applications is lacking due to lack of rigorous database development. By contrast, biologists and ecologists who entered the environmental impact field during the past twenty years brought relatively little in the way of a conceptual framework, but they did put major efforts into database development. The result is that the ecologists and biologists have a much better site-specific knowledge of environmental impacts which gives added credibility to their findings.

The fundamental data gaps are most serious for agricultural activities which tend to be of major importance at the river basin scale. For example, if water withdrawals for irrigation are not measured, then the ability to do an accurate assessment of irrigation benefits is quite limited. Thus, it is vital to evaluate the extent to which available data will support the use of various analytical methods. On the cost side, the P&G is not very informative but other federal guidance documents and cost-estimating models are quite helpful. Some vexing issues related to cost allocation remain, but these can be dealt with in later stages of the cost analysis.

The P&G (1983) and supporting IWR reports on specific project purposes are conceptually sound and provide good general guidance. In summary, the suggested analytical approach to use is as follows:

1. Estimate benefits by purpose but keep accounts for all affected groups.

2. Place strong emphasis on developing a high quality database so that the estimates are creditable.

3. Develop and calibrate a continuous simulation model to perform this analysis.

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APPENDIX B
ISSUES IN THE VALUATION OF ENVIRONMENTAL RESOURCES: A PERSPECTIVE FROM THE PSYCHOLOGY OF DECISION MAKING

David A. Schkade

ISSUES IN THE VALUATION OF ENVIRONMENTAL RESOURCES: A PERSPECTIVE FROM THE PSYCHOLOGY OF DECISION MAKING

EXECUTIVE SUMMARY

In contrast to previous historical periods in which the U.S. Army Corps of Engineers was able to operate with considerable autonomy in selecting, developing and managing water projects, it now faces an environment in which decisions must be made in consultation with state and local officials, and even with various interest groups. This marked change has arisen through many developments, but principally because of the increased requirement for cost sharing with state and local governments for Corps project and the increased legal status of various effects of Corps projects under recent statutes and associated regulations such as the Clean Water Act of 1991. In this new environment, the preferences and beliefs of the public concerning environmental resources have been transformed from essentially public relations matters to potentially dramatic influences on the policies and actions available to the Corps. Thus, an important objective for the Corps would seem to be to devise a mechanism for incorporating these influences in a way that makes them as predictable and as manageable as possible.

Unfortunately, the results of over three decades of research on how people form and express their preferences suggests that measuring them may be a challenging undertaking. Most people apparently do not have well-formed values for each of the vast array of environmental resources that could potentially confront them. Rather, people seldom think about the value of an environmental commodity until they are asked about it. Based on the results of hundreds of empirical studies from the resource economics and decision making disciplines, it does seem extremely likely that the average citizen's value for restoring or maintaining a given environmental resource is more than zero. However, because these preferences are usually quite vague and are given specific form only in response to a question, little more can be said with any confidence about the precise magnitude of the monetary values that attach to them. Efforts to attach precise numbers to these preferences have been plagued by unwanted methodological influences that lead mostly to the conclusion that the answer depends heavily on how the question is asked. It is yet possible that people may be able to reliably rank in order a set of environmental resources that are presented to them. This is an empirical question that deserves further study. But in the end, the overwhelming verdict of the evidence is that a "true" parameter value that represents the public's monetary value for restoring or maintaining a given environmental resource probably does not exist in any practical sense.

The most useful position that the Corps can take is to assume that the value of a resource is constructed through some social interaction or negotiation, and is therefore inherently influenced by the particulars of the process of construction. Indeed, many stakeholders may even judge the value of a proposed action based in part on their perceptions of the decision- making process. Therefore, the Corps should place a high priority on learning how to design and conduct the process of value construction in ways that produce acceptable and implementable value representations. The Gregory, Lichtenstein and Slovic (1993) multiattribute utility approach is a significant step in this direction, where relevant constituencies are explicitly and intentionally involved in the process of value

construction, rather than being passive participants for whom only a single isolated feature such as willingness-to-pay is to be measured. Regardless of the specific approach taken, it behooves the Corps to take control of its destiny by developing expertise in such procedures, lest these stakeholder interactions become an unpredictable and uncontrollable tail wagging the water project dog.

INTRODUCTION

In contrast to previous historical periods in which the U.S. Army Corps of Engineers was able to operate with considerable autonomy in selecting, developing and managing water projects, it now faces an environment in which decisions must be made in consultation with state and local officials, and even with various interest groups. This marked change has arisen through many developments, but principally because of the increased requirement for cost sharing with state and local governments for Corps project and the increased legal status of various effects of Corps projects under recent statutes and associated regulations such as the Clean Water Act of 1991. In this new environment, the preferences and beliefs of the public concerning environmental resources have been transformed from essentially public relations matters to potentially dramatic influences on the policies and actions available to the Corps. Thus, an important objective for the Corps would seem to be to devise a mechanism for incorporating these influences in a way that makes them as predictable and as manageable as possible.

If the preferences and beliefs of these other groups were similar to those within the Corps, then incorporating them into the decision making process would not be a huge challenge. However, there is much evidence that the public often views things quite differently than scientists or technical experts (e.g., Slovic, Fischhoff & Lichtenstein, 1982). For example, even if both groups are presented with the same technical data, citizens may interpret it differently (expert - "the probability of this risk is effectively 0"; citizen - "Oh my god, I didn't even know that could happen - it sounds horrible"), or even reject the validity or relevance of the data ("I don't understand where these numbers came from" or "those engineers don't speak for me"). More significantly, even if a common fact base can be achieved, the public often has legitimately different preferences for alternative states of the environment than technical experts (e.g., NIMBY). Thus, without further investigation it seems unlikely that the Corps can anticipate the beliefs and preferences of stakeholder groups by extrapolating from its own.

The goal of this paper is to characterize, from a psychological perspective, what is currently known about how people arrive at their valuations for environmental resources. First, the findings of over four decades of research on the psychology of preferences will be briefly reviewed to place the analysis of preferences for environmental resources in context. Second, conceptual issues surrounding how people think about environmental resources are reviewed and discussed. Finally, the state of the art in measurement techniques for the value of environmental resources is assessed from a psychological perspective.

THE PSYCHOLOGY OF PREFERENCES

It surprises many who are not economists or psychologists to learn that the two disciplines have had relatively little interaction despite shared interests in the prediction and interpretation of choices. While interaction on these issues may seem potentially profitable in situations where markets are present, the need is even greater where markets are absent, for example, when public goods such as environmental resources are under study. Interactions between psychology and economics have been increasing in recent years (see for example, Hogarth and Reder, 1986), although the seeds of their development were planted over four decades ago. In many ways, the challenges posed by the valuation of environmental resources brings into joint focus several different streams of thought, each of which has been decades in the making. The following brief stroll through history is not a casual one, however, as many of the issues surrounding the psychology of environmental resource valuation are not new, and can be placed squarely within long-term and inexorable trends in the study of preferences.

A Brief History

The two principle cornerstones of future interaction between economists and psychologists were laid in the midst of an explosion of work on mathematical models of choice that followed the seminal work on utility theory of von Neumann and Morgenstern (1947). In 1954, Ward Edwards first introduced psychologists to these formal models of rational choice, arguing that they could be used as normative benchmarks against which to evaluate judgment and decision making behavior. This insight led to the development of the paradigm that was to form the core of later work on the psychology of decision making, in which the manner and conditions under which actual decision behavior deviates from a normative benchmark is the principle window into underlying cognitive mechanisms. Concurrently, Herbert Simon (1955) was challenging economists to question the basic behavioral assumptions of their mathematical models of rational behavior. He argued that humans lacked the information processing and computational capacity required to achieve utility maximization, and, therefore, that models of rational choice could not, even in principle, describe actual choice behavior ("what a man cannot do he will not do"). Consequently, humans are bounded in their rationality, using simplified and approximate methods ("heuristics") to achieve satisfactory solutions to their problems, rather than aspiring to the optimality assumed by economic models. These two distinct, though related, lines of reasoning were to be principal factors in the development of a new and important sub-discipline within psychology, *behavioral decision research,*[12] and ultimately to a recognition by economists of the serious questions posed by Simon's challenge to the descriptive validity of economic models of rational behavior.

Early behavioral decision research in the 1960s and 1970s focused on identifying tasks and circumstances where systematically irrational behavior occurred, as measured against the definition of rationality embodied in economic models. Sarah Lichtenstein and Paul Slovic (1971) discovered

[12] As an indication of the vitality of this new subdsicipline, during the decade of the 1980s two leading behavioral decision researchers, Daniel Kahneman and Amos Tversky, were the second and fourth most cited authors in any area of psychology.

one of the earliest and still most important phenomena of this genre, *preference reversals,* which occur when the preference ordering for two objects varies across different response modes, such as willingness to pay (WTP), choice, rating, and ranking. Preference reversals and other related phenomena violate the principle of *procedure invariance:* normatively equivalent procedures should result in the same order of preference for a set of objects (Tversky, Sattath & Slovic, 1988). Preference reversals have subsequently been found in a wide variety of tasks and contexts in which economic theory states that they should not occur (Slovic & Lichtenstein, 1983), including some recent contingent valuation (CV) studies. For example, Julie Irwin and colleagues (1993) studied the effect of eliciting preferences for consumer goods versus improvements in air quality using two response modes: WTP and choice. Their results showed that respondents were willing to pay more for improvements in consumer goods than for improvements in air quality when responding with WTP, but favored improvements in air quality when making a direct choice between the two. Hundreds of other efforts by behavioral decision researchers uncovered a long list of judgment and decision making biases that challenged the assumption of economic rationality (Kahneman, Slovic & Tversky, 1982). The surprising sensitivity of decision behavior to seemingly insignificant variations in the procedure or problem description was the dominant theme of the first two decades of this research. Table 1 provides a brief overview of some of these findings that are of particular importance for the current context.

TABLE B-1
SOME CONCLUSIONS FROM BEHAVIORAL DECISION RESEARCH

- People usually do not solve complex problems in their original form -- they either adopt a simplified version of the problem and then solve it or use heuristic strategies that ignore parts of the problem.
- People often change their preference ordering for the same options when the description of the options or the procedure for responding are changed.
- People tend to overestimate how much they know about a problem (e.g., excessive confidence in point estimates of unknown parameters).
- People tend to accept information in the form it is presented (e.g., to assume information in a questionnaire is correct).
- People are equally confident in their answer to a partial version of a decision problem and their answer to a complete version.
- People are relatively insensitive to the reliability of information (e.g., a small sample often has the same effect on beliefs as a larger sample)
- People base their perceptions of decision risk on many factors besides the expectation and variance of possible decision outcomes.
- People adapt their decision approach to the situation (i.e., no one uses the same decision strategy in every situation).

Yet, by the end of the 1970s, economists had paid relatively little attention to the challenge to their models that the results of behavioral decision research represented. Three events occurring in 1979 signaled a coming change in this view (although many other factors also contributed). First, two respected economists, David Grether and Charles Plott, published a paper in which they replicated Lichtenstein and Slovic's preference reversal results under severe conditions imposed by some thirteen different economics-based criticisms. This article by economists, which was published in the premier journal of the discipline, the *American Economic Review*, was widely discussed in the field. Second was the publication in another premier economics journal, *Econometrica*, of an important theoretical paper by two behavioral decision researchers, Daniel Kahneman and Amos Tversky, that presented a formal descriptive model of choice behavior as an alternative to the traditional rational choice model. A decade of efforts by economists and decision researchers alike to generalize the traditional model to accommodate behavioral biases followed. Finally, and perhaps most symbolically, Herbert Simon was awarded the 1979 Nobel prize in economics, which in part represented a recognition by economists of the serious questions posed by his challenge to the descriptive validity of rational choice models. Subsequently, efforts by economists to give greater attention to issues of empirical validity as well as to build bridges to psychological research have become more frequent, as exemplified by the 1986 economics-psychology conference at the University of Chicago, whose participants included six then and eventual Nobel prize winners, as well as numerous other luminaries from both the psychology and economics fields (Hogarth & Reder, 1986). While it is hardly the case that economists are abandoning the traditional models in droves, the foundations of rational choice models have become legitimate topics for critical debate.

Constructive Preferences

If an implication of behavioral decision research is that people are not always rational (at least in the way economists define rationality), then two obvious questions are: "Why aren't they?" and "What do they do instead?" The simplest answer to the first question is Simon's, that these difficulties are the inevitable consequence of fundamental limits on human cognitive abilities to encode, process, and recall information. That is, the barrage of problems, decisions, information, and other stimuli that the complexity of the real world compels upon us overwhelms our processing capacity. As James March (1978) states in his discussion of human preferences, "Human beings have unstable, inconsistent, incompletely evoked, and imprecise goals at least in part because human abilities limit preference orderliness" (p. 598). What someone cannot do they will not do.

Does this mean that people are fundamentally random and unpredictable? Does this pessimistic assessment of human decision making abilities preclude hope of discovering useful regularities in preferences? Clearly not. Indeed, all of the psychological research referred to above relies on the assumption that people are quite purposeful in their activities, and are even "rational" in the more familiar sense that they attempt to choose means that are likely to achieve their desired ends. What is most interesting about the various errors and biases revealed in the literature is precisely the fact that they are systematic, and therefore explainable, and in some fortunate cases, even predictable. Further, many of these biases are modest in size or occur within a limited range of situations. For example, virtually all studies of preference reversal have used decision alternatives that are quite close in value, so that the reversals demonstrated usually do not mean that people are oscillating between wild extremes. Common sense usually rescues people from such outcomes. People probably do intuitively attempt to do something like utility maximization, but achieve it to only a fairly gross and common-sensical degree.

Where does this leave us as a practical matter in our quest to understand preferences? Students of preferences differ considerably in the core assumptions they make about the nature of the values that are available for elicitation. At one extreme is what Fischhoff (1991) calls the "philosophy of articulated values," which assumes that people have well-formed preferences about any relevant topic, and can directly retrieve an appropriate response to an elicitation question. Adopting this view leads to a focus on finding the correct methodology for eliciting values, as has been the emphasis in the CV literature (e.g., Mitchell & Carson, 1989). At the other extreme is the "philosophy of basic values," which assumes that people have well-defined values only for very familiar topics. Under this presumption, people must derive specific valuations for less familiar topics through some inferential process. This view leads to the conclusion that in many if not most cases, people must *construct* their responses at the time they are asked an elicitation question, rather than *retrieve* a previously formed value (Slovic, Griffin & Tversky, 1990). A key implication of a more constructive view of preferences is that elicited values are heavily influenced by the particular features of the elicitation process.

Thus, the constructive perspective provides a cognitive mechanism that explains the sensitivity of expressed values to methodological factors that has been the hallmark of much decision research. Different combinations of these factors can emphasize different aspects of the problem and thereby evoke different processes for arriving at a decision. In this way, characteristics of the decision problem at least partially determine the preferences and beliefs we observe. Fischhoff, Slovic, and Lichtenstein (1980) argue that “expressed values seem to be highly labile” (p. 137). That is, “subtle aspects of how problems are posed, questions are phrased, and responses are elicited can have substantial impact on judgments that supposedly express people’s true values” (p. 118). Further, the idea of constructive preferences goes beyond a mere denial that observed preferences result from retrieving the appropriate value from a mental master list in memory. It also means that preferences are not necessarily generated by some consistent and invariant algorithm, such as an expected utility calculation (Tversky, Sattath & Slovic, 1988). It appears that decision makers have a repertoire of methods for identifying their preferences and developing their beliefs. These multiple methods or strategies result from both experience and training (see Payne, Bettman & Johnson, 1992).

Of course, not all preference tasks are likely to generate a constructive response (Table 2). Sometimes people do have well-articulated preferences or have a consistent algorithm for generating a response (e.g., calculating the net present value of a cash flow) (Tversky, Sattath & Slovic, 1988). In the context of CV studies, such values are sometimes referred to as *crystallized* (McClelland et al., 1990). More generally, see Fischhoff (1991), McFadden & Leonard (1993) and Plott (1993) for a discussion of conditions conducive to well-articulated values.

TABLE B-2
CONDITIONS FAVORABLE TO WELL-ARTICULATED VALUES
(adapted from Fischhoff, 1991)

- Familiar topic
- Personally important topic
- Information about topic is available and well-understood
- Uncontroversial topic

- Outcomes are few in number
- Outcomes are easy to compare or combine
- Outcomes will be directly experienced
- Little uncertainty about outcomes of actions

- Respondent's role in topic is well defined and straightforward
- Topic considered in isolation from others
- Information presented in a familiar format

THE PSYCHOLOGY OF ENVIRONMENTAL RESOURCE VALUATION

Most people do not spend a lot of time thinking about the environment, although they do so occasionally. Even fewer spend their leisure time pondering the monetary value of a potential change in the environment.[13] It is probable that, like most things, people think about the environment mostly in response to a news account, tales of a picturesque vacation in an unspoiled location, or some other unsolicited stimulus. Those environmental resources heard about through the media are most often far away and not in a person's direct experience (e.g., Persian Gulf, Brazilian rain forest, in another state). Also, since no action is required by these occasional episodes, people spend little time considering commitment to a course of action. The infrequent times that people are engaged more intensely usually occur when some resource very near their residence is damaged in some way or threatened by proposed development. In this case, they may gain a rich set of details about a specific site or type of problem.

If this haphazard type of experience constitutes a good portion of a person's exposure to environmental resources, what type of preferences will be developed? The brief and shallow brushes with the subject matter are not a promising basis for the development of deep and detailed beliefs and preferences about the environment. An intense experience with a given resource may engender strong feelings, but not be very representative of other types of resources or locations. In addition to this information, people no doubt draw also on basic values derived from their childhood, personal

[13] Many financial planners and accountants make their living just trying to get people to think about immediate and already realized budgetary issues.

experiences, or religious and philosophical beliefs. These sources may paradoxically give rise to deeply held but vague preferences. These individual shallow experiences may simply add to the person's overall perceptions about the environment, rather than contributing to the development of a more differentiated view. Thus, many people may develop vague, nonspecific, but paradoxically deeply held preferences. Such preferences may be many things, but are probably not well-articulated.

When people are asked to state their value for an environmental resource, how do they go about responding? Answering such a question is a daunting task, characterized by a lack of well formed preferences, feelings of uncertainty about the future outcomes of proposed policies, simplistic mental models of environmental functioning that extrapolate poorly to a real situation, and doubts about the credibility of information from scientific, business, or government sources. But if someone is asked for a number, they will generally oblige with one, finding inventive and sometimes surprising mechanisms for answering. Schkade & Payne (1994) asked respondents to a contingent valuation survey to think aloud as they formulated their WTP. A series of verbatim excerpts are reproduced in Appendix 1. The dominant theme that characterized the considerable variety in considerations that various respondents used was a struggle to redefine the problem as a more familiar one that they knew how to answer. If we measure a task with these conditions against the list of criteria in Table 2, it is a situation almost certain to engender constructive preferences. Alternatively, since people have, at best, a vague understanding of both the scientific functioning of environment and their preferences for it, they may even judge proposed policies based on their perception of the process by which it is generated (e.g., "was my group represented?"), rather than based on the substance. The outcomes of such policies are off in the murky future, whereas the process is current and more easily observed.

In many ways, asking someone about their value for an environmental resource has much in common with the preference tasks that behavioral decision researchers have studied for years. Questions are initiated by a researcher or consultant, rather than by the respondent, key information about the problem is provided by the researcher, the respondent is limited in their response by the format of the task, etc. Several authors have suggested that the construction of preferences may be common in CV studies (Fischhoff & Furby, 1988; Gregory, Lichtenstein & Slovic, 1993). Mitchell and Carson (1989) do acknowledge that "people tend not to have previously well-defined values for many of the goods valued in CV studies" (p. 249). However, they go on to argue that improvements in method can overcome the potential biases resulting from this lack of well-defined values.

A constructive view of decision making suggests at least three sources of such task and context effects. First, decisions are often complex. CV tasks, in particular, can involve environmental resources, payment vehicles, etc., that have many diverse dimensions. In addition, as noted by Gregory et al. (1993), environmental resources are not normally thought of in quantitative (dollar) terms. Because decision makers typically simplify a complex problem such as this in many different ways, failures of invariance may be related to task complexity. Examples of the ways decision makers have been found to simplify problems include adopting a strategy of screening out decidedly inferior options from a large set of possibilities or emphasizing those elements that are most compatible with the response mode (see Payne, Bettman & Johnson, 1992).

Second, decisions often involve conflicting values, where a decision must be made on how much to value one attribute of a problem, relative to another. This is the task presented to respondents in a CV study. In trying to deal with such conflicts, people often adopt different strategies in different situations. This strategy switching can cause variance across situations (e.g., across response modes).

Third, even if we know what we will get upon choosing a particular option, we may not know how we will feel about it (Kahneman & Snell, 1990). For example, we may know that a prestigious Ivy League school offers a competitive and high-pressure graduate program, but we might be quite unsure about how well we would like such an environment. Hence, invariance may fail because of uncertainty in our underlying values, even when we know what we will receive. We suspect that the typical CV task is characterized by much uncertainty in values.

An obvious hypothesis, for which there is some support, is that the more ambiguity in one's preferences, perhaps due to a lack of familiarity with the objects in question, the more one's expressed preferences will be subject to procedural and descriptive influences. For example, Hoch and Ha (1986) and Levin and Gaeth (1988) found that in the context of product evaluations, the more ambiguous a consumer's experience with a product, the more their evaluations are susceptible to how the product is described. Recently, Cox and Grether (1992) have shown that repeated experience *and* proper incentives can reduce the frequency of preference reversals. Unfortunately, CV is often of greatest interest when valuing novel or unfamiliar resources (especially for nonuse values). In such a case, the respondent is likely to be influenced by whatever cues are available, whether from their own limited experience or from the questionnaire itself (Harris, Driver & McLaughlin, 1989). McClelland et al. (1992) also emphasize that nonuse values must be constructed by respondents, rather than be retrieved from a list of existing values.

Thus, it seems particularly likely that CV will evoke constructed rather than well-articulated preferences. If responses to CV questions are indeed constructed, we would expect them to be highly sensitive to features of the task and context that could influence the process of construction. That is, it may be inevitable that CV values for unfamiliar goods will be greatly affected by the context of elicitation. To summarize, the literature on the psychology of preferences suggests that the susceptibility of CV results to various influences is just one example among many of how expressed preferences are sensitive to task and context factors, and often in ways not easily reconciled with the assumptions of the economic model that underlies contingent valuation.

THE STATE OF THE ART IN MEASUREMENT: A PSYCHOLOGICAL PERSPECTIVE ON CONTINGENT VALUATION

Researchers have worked for many years to develop methods to measure the values of environmental resources for which there are no relevant markets. In particular, researchers have been concerned with the development of methods that could measure "nonuse" values such as an existence value—the value placed on simply knowing that a resource exists independent of any current or possible future use value (Krutilla, 1967). Some experts believe that CV is the only method that can measure both use value and nonuse or "passive-use" value. The CV method uses surveys to create hypothetical markets for an environmental resource. A typical WTP question in a CV survey aims to elicit from the respondent the "change in his income, coupled with the change in the level of the public good, leaves his utility level unchanged" (Mitchell and Carson, 1989). As an example of such a question, consider the following scenario: Suppose respondents are told that 200,000 ducks, geese, and other migratory waterfowl were dying each year from contact with oil, gas, and other by-products of production and drilling operations in a distant region of the country.[14] A CV question might be "What is the most your household would agree to pay in higher prices for oil and gas to prevent these 200,000 birds from dying each year from this issue?" Thus, respondents are asked to determine the reduction in their annual disposable income (the stated WTP amount) that would leave them indifferent between the current level of an environmental good (the annual loss of a specified number of waterfowl) and the hypothetical improvement in the supply of an environmental good (protection of a specified number of waterfowl). If respondents answer as assumed, the resulting values correspond to the economic value of the resource as measured by the Hicksian compensating surplus (Mitchell and Carson, 1989).

Kahneman (1986) notes that the basic presumption underlying contingent valuation, whatever the question format, is that "there exists a set of coherent preferences for goods, including nonmarket goods such as clean air and nice views; that these preferences will be revealed by a proper market; and that these preferences can be recovered by CV" (p.192). Studies have shown that CV results can be reliable in a test-retest sense and, in the case of use values for familiar goods, generally correspond to the values obtained by other methods (see Loomis, 1990, for an example of a reliability study and Cummings & Harrison, 1992, for a general review of literature on CV). A growing body of research, however, suggests that the presumption of a coherent set of preferences is questionable, particularly in the case of nonuse values for unfamiliar natural resources. More specifically, an increasing body of research shows that contingent valuation responses are sensitive to methodological factors that some argue are theoretically irrelevant to the underlying value of the resource (e.g., Cummings & Harrison, 1992; Irwin et al., 1993; McClelland et al., 1992; Peterson, Driver & Gregory, 1988), as well as sometimes relatively insensitive to certain factors that might reasonably be expected to influence WTP responses (e.g., Boyle, et al., 1994; Kahneman & Knetsch, 1992).

Of course, there are likely to be disagreements about exactly which effects of task (e.g., response mode) and context (e.g., embedding) are theoretically irrelevant or relevant and which levels of sensitivity to such variables are reasonable to expect in various situations (e.g., see Milgrom, 1993; Peterson, Driver & Gregory, 1988). Nonetheless, the findings of task and context effects have led many researchers concerned with the application of contingent valuation methods to speculate about what may be going through respondents' minds when answering WTP questions. Respondents may indeed be trading off an increase in the level of an environmental resource against a decrease in wealth, as is generally assumed (Mitchell & Carson, 1989). However, researchers have suggested that other considerations may be operating as well in determining a CV response. These other considerations affect the interpretation given to the CV response. For instance, in addition to (or in place of) the value of the resource, respondents might be thinking of a contribution to a charity (Diamond & Hausman, 1993), the "warm glow of giving" or a feeling of moral satisfaction (Andreoni, 1990; Kahneman & Knetsch, 1992), or of some aspect of the payment vehicle (Mitchell & Carson, 1989) when coming up with their WTP response. Other possibilities include a symbolic response to a larger set of environmental issues (Mitchell & Carson, 1989), "doing your fair share"

[14]In an actual CV study, extensive details about the situation, proposed remedy, payment vehicle, etc., would be provided.

(Diamond & Hausman, 1993), and other strategic behaviors (Cummings & Harrison, 1992; Diamond & Hausman, 1993). More generally, it has been suggested that the respondent in a CV study may be responding to something quite different from the specific good for which the researcher hopes to obtain a willingness-to-pay. The next section discusses these and other concerns that have been raised about the validity of CV responses.

Issues Concerning the Validity of the CV Method

Question Format. Researchers increasingly are advocating framing the CV question like a vote on a referendum (such as a school bond issue) in which respondents are told how much each would have to pay if a measure dealing with a specified environmental resource were passed and then are asked for a simple "yes" or "no" vote. For example, a CV referendum question might take the form, "Would you be willing to be taxed Y dollars to cover the cost of avoiding or repairing environmental damage X?" Note that this form of CV question is essentially a choice response in which the respondents simply decide whether they prefer the option defined by the current levels of the environmental resource and wealth or the option defined by the proposed improvement in the environmental resource (+X) and decrease in wealth by the amount Y.

Both theoretical and practical advantages are cited for the referendum question format. One potential advantage of this form of CV question over the open-ended format is that choice is generally a cognitively easier task than the value-matching task required by the open-ended format (Tversky, Sattath, and Slovic, 1988; Schkade and Johnson, 1989; Payne, Bettman, and Johnson, 1992). Additionally, people are believed to have more experience with real referenda regarding the provision of public goods than with open-ended WTP questions. Also, since the results of actual referenda are taken seriously as valid preference measures, the results of hypothetical referenda in CV studies gain credibility. Recently, the NOAA panel on using CV to determine nonuse values strongly recommended the referendum form of CV question (U.S. Department of Commerce, 1993).

The referendum format is not without disadvantages, however. Recent research has shown that respondents have a tendency to answer favorably even at very high bids (Kanninen, 1993, Boyle et al., forthcoming). Boyle et al. cite an example of this so-called "yea-saying" bias where more than 30 percent of respondents stated they would agree to pay $1,000 a year to prevent environmental damages from oil spills. This bias produces a thick tail in the empirical distribution of responses, which substantially increases the location and variability of the mean WTP estimates. Other difficulties with this question format include sensitivity to the list of bid amounts that are offered to respondents (see Loomis, 1989; Boyle et al., 1994; and McFadden & Leonard, 1993). Much remains to be seen concerning the reliability and validity of responses to CV referendum questions.

Willingness-to-pay versus willingness-to-accept. When an environmental resource has or will be altered, the theoretically appropriate measure concerns compensation, that is, the minimum payment people would be willing-to-accept (WTA) in return for the damage. Unfortunately, this type of question often results in absurdly large answers ("Since I'm not paying, I'll ask for all I can get"). As a result, CV researchers have turned to WTP, because it produces a theoretical lower bound on

WTA, and people are less likely to offer to pay huge amounts (that may be large proportions of their income, or even exceed it).

Unfortunately, WTP brings to mind all sorts of irrelevant issues, such as the appropriateness of the payment vehicle, the effectiveness of the proposed remedy, who should pay, and many others. The choice of WTP rather than WTA, implicitly acknowledges that people employ other considerations than those required by the economic model when answering such questions. Further, justifications for this choice also cite the "conservative" estimates that it provides. However, since we cannot validate either of these types of question, there is no way to tell whether the adjustment achieved by using WTP rather than WTA is too large or too small. At best, making this adjustment is an (barely) educated guess, and at worst it is a mere shot in the dark. For example, using the best available practice, the WTP for damage to Prince William sound estimated by the team of government experts (which included Mitchell, Carson, and Hanemann) was $2.9 billion. This is a remarkable number for a site that less than 1% of the population had ever heard of before the Exxon Valdez incident. It was meaningful only because one of the world's ten largest corporations was involved, as it would completely bankrupt the vast majority of potential polluters. How conservative should these estimates be considered if they are even still too large to be practically actionable?

Inadequate responsiveness to the scope of the environmental insult. According to the recent NOAA panel report, perhaps the most important specific evidence on the reliability of the CV method relates to the "embedding phenomenon" (U.S. Department of Commerce, 1993). For instance, in one study, Kahneman (1986) found that the WTP for the cleanup of all lakes in Ontario was only slightly more than the WTP for cleaning up the lakes in just one region of Ontario. In a more recent study of this phenomenon, Boyle et al. (1994) found that the average WTP to take measures to prevent 2,000 migratory birds (not endangered species) from dying in oil-filled ponds was as great as that for preventing 20,000 or 200,000 birds from dying. As noted in the recent NOAA panel report, "Diminishing marginal WTP for additional protection could be expected to result in some drop. But a drop to zero, especially when the WTP for the first 2,000 birds is certainly not trivial, is hard to explain as the expression of a consistent, rational set of choices" (U.S. Department of Commerce, 1993). Thus, independent samples of respondents may not provide WTP amounts that vary as predicted by utility theory.

Why might WTP responses show an inadequate responsiveness to the scope of the environmental insult? Some have argued that the studies showing such an effect do not employ "best" CV practices. For example, the Boyle et al. (forthcoming) study has been criticized as using an open-ended WTP form of question rather than the referendum format. It has also been criticized because the respondents were told that 2,000 birds was much less than one percent of the total migratory bird population and that 200,000 birds was about two percent of the total. The argument is that respondents may have been led to evaluate the programs as being essentially the same. Although, as noted by the NOAA panel, if the percentage of the total were such a salient issue, it makes one wonder why the stated WTP amounts for the less than one percent scenario was so substantial (i.e., about $80 per household per year).

Another possible explanation for the embedding effect is that the relative insensitivity of expressed WTP amounts reflects "a warm glow of giving" (Andreoni, 1990) or the purchase of moral satisfaction (Kahneman and Knetsch, 1992) rather than a purchase of a specified improvement in a particular environmental resource at a stated price. A related idea is that there is a symbolic bias in the CV responses in which "respondents react to an amenity's general symbolic meaning instead of to the specific levels of provision described… a propensity to respond to the symbol rather than to the substance" (Mitchell and Carson, 1989). These arguments are consistent with the basic values philosophy in which people can reliably determine that this is a good cause, but not a more specific numerical value. Other possible motives that have been mentioned include "doing your fair share" (Diamond and Hausman, 1993) and the CV response as a symbolic response signaling a concern for a larger set of environmental issues (Mitchell and Carson, 1989). When Schkade and Payne (1994) asked respondents to "think aloud" while answering a CV question, they found that these and several other motivations were mentioned, few of which would be anticipated by economic theory (see Appendix 1). The recent NOAA panel report (U.S. Department of Commerce, 1993) concluded that respondents' answers to follow-ups to the CV referendum question should refer to the cost and/or value of the program. If they do not, this would be sufficient to judge the CV responses as "unreliable." Thus, it appears that in judging the responses to a CV survey one must be concerned not only with the values of the CV responses that are generated, but also with the reasoning behind those numbers.

Inadequate consideration of alternative expenditure possibilities. Generally, a concern has existed among researchers about the magnitude of CV responses, and especially whether one could simply add the individual estimates for various changes in quality and get a reliable total estimate. One possibility is that respondents did not adequately consider the number and range of possible environmental causes that they might value. Recently, Hoehn and Loomis (1993) have shown that substitution among resources can affect the magnitude of CV responses. More generally, people may not adequately consider the number and range of other possible uses of the amounts they are willing to pay for the particular environmental good in the CV scenario (Kemp and Maxwell, 1993; Smith, 1992). Some evidence in support of this concern was obtained in Schkade and Payne (1994). In that study, respondents were asked, after generating a CV response to a particular scenario, if they would be willing to support other important issues with a similar dollar amount. When confronted with this question about other causes, several respondents suddenly realized the far-reaching implications for their household budget of the their previous WTP response, and indicated that the amount they stated was really too large or that it should go for all similar issues.

This reaction is consistent with the idea that people often adopt a "minimal mental account" (i.e., a narrow definition of the problem) when making a decision, "often isolating the current problem from other choices that may be pending, as well as from future opportunities to make similar decisions" (Kahneman and Lovallo, 1993). Similarly, Randall and Hoehn (1992) have recently suggested that respondents have "tunnel vision" and conduct an incomplete search of the opportunity set, possibly leading to embedding effects. As a way of dealing with the narrow-definition problem, the NOAA panel has recommended that respondents be reminded "forcefully" of substitute commodities and other things on which respondents could spend their money directly prior to the main valuation question (U.S. Department of Commerce, 1993).

SUMMARY AND CONCLUSION

The results of over three decades of research on how people form and express their preferences suggests that measuring them may be a very challenging undertaking. Most people apparently do not have well-formed values for each of the vast array of environmental resources that could potentially confront them. Rather, people do not usually think about the value of an environmental commodity until they are asked about it. Based on the results of hundreds of empirical studies from the resource economics and decision making disciplines, it does seem extremely likely that the average citizen's value for restoring or maintaining a given environmental resource is more than zero. However, because these preferences are usually quite vague and are given specific form only in response to a question, little more can be said with any confidence about the precise magnitude of the monetary values that attach to them. Efforts to attach precise numbers to these preferences have been plagued by unwanted methodological influences that lead mostly to the conclusion that the answer depends heavily on how the question is asked. It is yet possible that people may be able to reliably rank in order a set of environmental resources that are presented to them. This is an empirical question that deserves further study. But in the end, the overwhelming verdict of the evidence is that a "true" parameter value that represents the public's monetary value for restoring or maintaining a given environmental resource probably does not exist in any practical sense. The quest for the "holy grail" of better measurement techniques is probably in vain.

The most useful position that the Corps can take is to assume that the value of a resource is constructed through some social interaction or negotiation, and is therefore inherently influenced by the particulars of the process of construction. Indeed, many stakeholders may even judge the value of a proposed action based in part on their perceptions of the decision making process. Therefore, the Corps should place a high priority on learning how to design and conduct the process of value construction in ways that produce acceptable and implementable value representations. The Gregory, Lichtenstein and Slovic (1993) multiattribute utility approach is a significant step in this direction, where relevant constituencies are explicitly and intentionally involved in the process of value construction, rather than being passive participants for whom only a single isolated feature such as willingness-to-pay is to be measured. Regardless of the specific approach taken, it behooves the Corps to take control of its destiny by developing expertise in such procedures, lest these stakeholder interactions become an unpredictable and uncontrollable tail wagging the water project dog.

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ATTACHMENT 1
EXCERPTS FROM THINK-ALOUD PROTOCOLS FOR A CV QUESTION
(from Schkade & Payne, 1994)

The number of migratory waterfowl killed was set at one of three levels: 2,000, 20,000, or 200,000 birds per year. After first answering several questions about their experiences with migratory waterfowl (e.g., hunting, bird watching), waste oil holding ponds and their effects on migratory waterfowl in the Central Flyway were described in considerable detail. Respondents were then asked the following WTP:

> If the proposed regulations are approved, oil companies would pass on the costs of the wire net covers to consumers in the form of higher prices. Higher petroleum product prices would, in turn, increase the prices of most other things that you buy.
>
> **It is important to know how much protecting these migratory waterfowl is worth to you. Please think about:**
>
> * Your current household income
> * Your current household expenses
> * Other possible uses for your household income
>
> Keeping these factors in mind, what is the **most** that your household would agree to pay **each year** in higher prices for wire-net covers to prevent about 2,000(20,000)(200,000) migratory waterfowl from dying each year in waste-oil holding ponds in the Central Flyway?
>
> $ _______ per year

The most common consideration in our sample involves first acknowledging that something should be done and then trying to figure out how much an appropriate amount would be. For instance, 41% of the sample mentioned the idea that if everyone did their part, each household would not have to give all that much. Indeed, respondents who used this reasoning did give significantly lower WTPs. This result is consistent with a recent finding by Kahneman that respondents give lower WTP responses when told that the size of the relevant population is large. Some respondents also wanted to be sure that their small payment would be effective in solving the problem, which would depend on many other people doing the same. These quotes illustrate this line of reasoning:

> "Um, this is very difficult to determine. You'd have to consider how many millions of people in the country would also be contributing to this. . . . as far as how much per family this would break down to and what is the cost of putting this netting over all the different ponds, and how many ponds there are, so that would be the cost. I mean, if it . . . comes out to be a couple of dollars per household, then it seems reasonable. If it comes out to something more than that, um, it seems a little high. . . . So I'm going to say . . . $5." [respondent #24]
>
> "I'd probably be willing to donate about $10 per year and I guess if the majority of the U.S. did that, you'd uh . . . go a long way towards deferring the cost of the wire net covers." [respondent #65]

> "Well, if everybody was required to pay this, I can't see why everybody couldn't put up at least 25 bucks in a year. That would more than cover it." [respondent #78]

A related strategy, which accounted for 23% of the sample, involved first accepting as inevitable that the consumer would pay higher prices, followed by an attempt to estimate how much this would amount to for them. Consider these responses:

> "Um, I figured like just about, uh well, 40 or 50% of the things that uh every individual uses in their everyday life is oil or petroleum-based. . . . If say, if they even added like a nickel to the price of a gallon of gas over the long run that's roughly about $80 to $100 there over a year's length of time and then, in my case, it would probably be a little bit more because I'm traveling about 15, 20 miles a day one way to work, so we're talking 40 miles a day, and uh, I mean I have a pretty efficient automobile, but we're talking gobs and gobs of gallons of gas each month and each year, so I think $100 is a pretty conservative estimate." [respondent #28]

> ". . . Right now I pay $1 a gallon. Say they tacked on, uh, 10 cents. Uh I would be willing to pay, uh, I'm doing this on an average of what I spend a day on gas. I spend on an average of about $5 a day and it's about $1 a gallon and averaging that, which I figured if I paid an extra 10 cents a gallon, which would come out to be $100 a year." [respondent #80]

These excerpts are fairly typical of respondents who attempted to estimate what their increased cost would be in that: (1) the main focus is on gasoline (despite the passing reference to other products in the first excerpt); and (2) the calculations or estimates are sometimes questionable. There was no relationship between this consideration and WTP.

While the first two considerations involve some form of calculation, based on either the proposed solution or the payment vehicle, another common strategy involved viewing the WTP amount as a contribution to a charity. Because the commodities that are judged in CV research are often unfamiliar, it seems natural for respondents to look for something they are familiar with (e.g., a charity) to serve as a point of reference for establishing their response. Respondents who used this strategy, which accounted for 17% of the sample, often referred to specific other causes or amounts given to those causes, and on average gave significantly lower WTPs. These excerpts illustrate this type of response:

> "I uh was just thinking about how I make a donation to like maybe the Fraternal Order of Police or to uh MADD or different types of, of things that are for the good of our society. . . . [$15]" [respondent #83]

> "Now for that I'm going to put maybe $10 per year because . . . that's what we normally contribute, my husband and I, to the, uh, presidential thing . . . when they fill out your income tax." [respondent #15]

> "Well, I usually give a small percentage of my income to charities, and uh the church and the biggest of my income goes to the church. To charities I usually give no more than $20, so that's how I arrived at my $20 figure." [respondent #38]

A substantial group, 23% of the sample, suggested a desire to signal their concern for larger or more inclusive issues, such as preserving the environment or leaving the planet in good condition for their progeny. This type of reasoning is consistent with the *symbolic bias* arguments of Mitchell and Carson (1989), who state, "Symbolic bias occurs when respondents react to an amenity's general symbolic meaning instead of to the specific levels of provision described . . . a propensity to respond to the symbol rather than to the substance" (p. 249). Similarly, the moral satisfaction arguments of Kahneman and Knetsch (1992) would suggest that respondents might be thinking of a larger or more inclusive resource than just migratory waterfowl in the Central Flyway. Respondents mentioning this consideration gave significantly higher WTP responses. Here are two examples:

> ". . . somebody has to watch out for the things like that, and along with economical problems and everything, waste and all that, I think $500 is not very much to spend each year in taking care of our world . . ." [respondent #79]

> ". . . I'm thinking like, um, I would pay $50, maybe even $100, $50-100 a year would sound about right to me. I think it's a little bit high, but I kind of think it's important because, um I feel it's important for us to preserve the wildlife, and not, not only ducks and geese, but other animals too. I feel like if we just continue to let things go, we're going to be paying money for other things that may not be quite as important, and when you're killing off all of these animals, and I don't think that's good. I'd like my children to see these animals one day ... when I have them." [respondent #2]

A surprisingly large segment, 20% of the sample, said that they just made up a number or guessed at an answer. This result may reflect the unusual and challenging task faced by respondents in a contingent valuation question. There was no significant relationship between this consideration and WTP. Here are some examples:

> "Um, I have no idea. I guess $500 sounds like a nice round number." [respondent #104]

> "I don't really know . . . this is confusing to me . . . I would be willing to pay higher [prices], but I really don't know how much. . . . OK. I just put down something -- I guessed. [$50]" [respondent #99]

> "Um, let's see what would I, I would probably, it's hard to say how much I would pay. I don't see how much it would really . . . I don't know how much it would really cost. . . . I'd probably say about $100 a year. . . . uh, just out of the blue. There was no thought really put into it, I think the $100 figure just popped into my head and that's why I put it down, really." [respondent #53]

> "Well . . . it was more or less, you know, an off the top of my head answer, I guess. But it sounded like a fairly significant amount for, you know, one person out of the

> millions of people living in this country . . . so I would say that would be a safe answer [$100].” [respondent #82]

Notable by their scarcity were statements in the protocols indicating that respondents considered how much they valued the birds or how much the birds were worth. Similarly, there were few instances of reasoning about the economic tradeoffs necessary to make a dollar payment. However, while few respondents directly verbalized the idea that they were trading off birds against money, 31% did mention their household income and expenses. There was no significant relationship between the use of this consideration and WTP. Here are three protocols that seemed to reflect a considered tradeoff between a limited budget and a *general* concern for the environment:

> "I'm not real happy about an increase in . . . outlay of money since things are pretty tight. But this is important, . . . and we do need to protect the environment as well as . . . keeping things . . . clean and possibly protecting those birds. Um I would say maybe about, um, I would not like to . . . spend more than an additional, say $1,000 per year. I know that's not a lot but that's about as much as I think I can afford" [respondent #11]

> “Uh, well . . . both my wife and I are retired, which means that the ability of us to support certain things financially is limited. And this would be, would have to be one of the lower . . . priorities in our budget, even though I would like it to be . . . higher, if I had the ability to pay . . . [$25]” [respondent #6]

> “Well, gee, I wish I could say a lot. However, I’m just come off a 6-month unemployment spree, still trying to make it back on my feet and every time I want to commit to some type of wildlife help program, I never find myself able to give very much. So current household income is not . . . very much, household expenses are extreme, because I’m still trying to catch up. Let’s see . . . . . what, $5 per month, 5 X 12, $60 per year.” [respondent #91]

APPENDIX C
ENVIRONMENTAL RESTORATION IN THE ARMY CORPS OF ENGINEERS: PLANNING AND VALUATION CHALLENGES

Leonard Shabman

ENVIRONMENTAL RESTORATION IN THE ARMY CORPS OF ENGINEERS: PLANNING AND VALUATION CHALLENGES

INTRODUCTION

The traditional U.S. Army Corps of Engineers (USACE) project was expected to promote the nation's "economic" prosperity through construction of dams, channels, locks and ports. Such engineering works altered watershed hydrology, wetlands, and riparian areas for achieving flood hazard reduction, enhanced transportation opportunities, and water supply storage. Today, a restoration alternative might reverse the effects of these past development projects in order to replicate some prior hydrologic regime, to re-create some historic riparian zone or re-flood some drained wetland (Shabman 1994). *In general, the term "restoration" describes a class of water and land management alternatives intended to return to some historic watershed condition* (National Research Council 1993).

Sometimes a restoration alternative is just a modest change in the operation of an existing USACE project. In this case, project benefits are not compromised and financial costs for the project are insignificant. At other times, a restoration alternative may involve major alteration to the existing watershed condition. This alternative may have opportunity costs such as increased flood risk, reduced navigation capacity or less generous irrigation water supply. In addition, significant financial outlays by governments and by individuals may be required for implementing that restoration alternative. In these cases, the "value" of the restoration project will need to be compared with the expected costs. This review focuses on how the USACE can adapt its long standing planning approaches to restoration alternatives having significant costs.

Recently the USACE developed draft restoration project planning guidelines (USACE 1994) that will be modified over time based on experience and on the findings from the Evaluation of Environmental Investments Research Program (EEIRP). One work unit of EEIRP is to review monetary and other valuation techniques for environmental investments, presumably to facilitate estimation of restoration benefits. This report is a contribution to that EEIRP work unit. However, only by a review of all the planning elements can the meaning of, and approaches to, valuation be clarified. Therefore, the scope of this discussion extends beyond formal valuation methods.

This paper is tailored to USACE's particular organizational circumstances. Therefore, conceptual discussions of planning theory and resource valuation only are introduced when they apply to the particular circumstances of the agency. In addition, the report draws upon recent experiences of the USACE in restoration planning to illustrate several themes.[15]

[15]The examples offered in this paper have been developed from the author's own experiences and from detailed discussions with Lynn Martin and Ken Orth of the Institute for Water Resources.

THE NEW CONTEXT FOR USACE PLANNING AND VALUATION

The final selection of a restoration alternative registers decision makers' judgment on whether the costs for a restoration project are warranted by the values received. Valuation is accomplished when a decision to implement a plan is made. Decision makers are those individuals and organizations that can block or advance implementation of an alternative. By this definition, individuals who allocate budgets in the USACE are decision makers. So, too, is the USACE planner whose professional analytical decisions create a particular perception of the watershed effects of an alternative. Decision makers also are those outside the USACE, indeed outside of government, who are able to take *effective* political or legal action to advance or thwart the USACE ability to implement an alternative. Such decision makers might be the USACE cost sharing partner, the national office of the Sierra Club or a local port authority. Decision making to select a restoration alternative requires agreement among decision makers.

Planning should be conducted to secure agreement among decision makers. Agreement must be grounded in a common perception of the "facts." For example, decision makers may have different perceptions of the effect of increased water deliveries on marsh survival. The ability to reach factual agreement might be served by a technical study using controlled experimental methods. In the past, the USACE might have conducted such a study and then asserted that its planners had established the relationship between water deliveries and marsh survival. However, the power of the USACE to assert analytical dominance has waned in recent years. Today, negotiation among the natural resource agencies of the Federal government and the states, as well as the traditional water development interests and environmental groups, takes place over "technical" decisions such as model selection, estimation of costs, and scope and quality of data bases.

Disagreements will always arise over the desirable outcomes of any action. Decision makers may agree upon the physical and biological effect of reduced water deliveries on a marsh, but disagree about the acceptability of the effect. Conflicts of this nature may need to be resolved so that one view is imposed over the others. In the past, USACE had sufficient power over contending interests to impose a viewpoint without concern that those in opposition might find an alternative decision forum to secure their preferences. Today, this ability has been dispersed to a number of agencies and nongovernment interests who have a variety of legal and political means for advancing their own values.

If the conflict is rooted in strongly held ideological positions, agreement may require selecting an alternative that avoids the conflict of values. In the example used here, the only way to reach agreement may be to find an alternative water source so the deliveries to the marsh will not be affected. However, the disagreement may be over positive or negative wealth effects on different groups, and not over ideological positions. In this case, agreement may be reached by offers of compensation from those benefiting to those harmed. Compensation may be in the form of small changes in the decision. For example, adding a fish ladder to a dam might compensate fish and wildlife advocates who would otherwise oppose the dam's construction because of lost recreation opportunities. In the case of restoration, compensation may need to flow to those who have benefited from dams, water diversions and drained wetlands, if benefits will be given up for restoration. For example, the purchase of farmers' water rights, the provision of alternative water sources or subsidies for the cost of water saving technology may be part of a restoration alternative.

The USACE's ability to assert the validity of its technical studies and to impose alternatives on resistant interests has diminished in the past three decades. The powerful past of the USACE was a time when there was a national consensus behind water development, a time when the perception of expertise being housed in executive agencies was rarely questioned, and a time when access to the courts and to the legislature was limited to a few. In the exercise of that historical power, the USACE developed a hierarchical organization that stressed central planning and budget control through the imposition and enforcement of planning procedures. *In this new era of diffused power, the USACE restoration planning and decision protocols will need to be conceived as supporting consensus building within a fragmented decision making process.*

ELEMENTS IN USACE PLANNING

Today, the expectation is that USACE planning will inform decision making (ers) by analyzing data using particular conceptual frameworks. Decision making is supported when the clarifying results of the analysis from each element allow a particular alternative to be selected in consideration of the tradeoff between alternative outcomes of a restoration project and its costs.

Element 1: Establish Planning Objectives

USACE planning is focused on a specific area specified by the law authorizing the study. That area may be defined as narrowly as a specific harbor or area of a city, or as broadly as a watershed the size of the Florida Everglades. Within that area, the agency is expected to address water and related land resource problems and opportunities such as urban flooding, sedimentation of channels or a decline of waterfowl numbers.

The definition of general problem areas must be followed by a statement of planning objectives. Planning objectives are *specific* statements that establish the desired directions of change in the watershed and must be stated in measurable terms. However, these are not end points that are to be achieved at minimum cost. Examples of planning objectives are to reduce flood damages in the downtown business district of city X, to increase the channel depth in the harbor at city Y or to increase the breeding pairs of mallards at site Z. Planning objectives must have enough specificity in their statement to permit the development of particular alternatives in Element 2.

Planning objectives might be stated as a surrogate for a broader conception of the general water resource problem. An example of a surrogate may be the use of an indicator species (a particular species of bird) to represent the general concept of ecological carrying capacity. Thus, a specific planning objective to "increase the population of mallard ducks in lake L," may be a surrogate for measuring improvements in the lake's "ecosystem health."

Element 2: Formulate Alternatives

Plan formulation is expected to consider all the measures available for addressing the planning objectives. Combinations of measures, defined as alternatives, will achieve different levels of satisfaction for each objective. For example, alternatives for flood damage reduction might include the two measures of a reservoir and mandatory purchase of flood insurance in different combinations. Alternatives for increasing mallard duck populations may include different combinations of the measures of water level control, vegetation planting and creation of nesting sites.

The terms used in production economics describe this planning element. Alternatives (inputs) are created by combining measures. The inputs produce different levels of satisfaction of the planning objectives (outputs). Thus, the relationship between alternatives and the planning objectives are analogous to a production function. Determining the relationship of inputs to outputs, or the production function, is Element 3.

Element 3: Measure the Effects of Alternatives on Planning Objectives

This element requires the application of all the engineering, biological and behavioral sciences, as well as extant literature, to estimate the change in the watershed condition with, versus without, the alternative. For example, methods in hydrology must be employed to establish the effect of a channel on flood heights and flow velocity at some location along the river. The effect of insurance purchase requirements on peoples' decisions to develop in flood prone areas might need to be established. The influence of a rise in energy costs on industrial plant location may need to be assessed. The influence of vegetation planting on reproduction and survival of mallard ducks might need to be estimated.

Knowing the effects of the alternatives is a requirement for the formal evaluation required by Element 4. Specifically, in order to evaluate an alternative, an estimate of its output is required. However many of these production relationships will be difficult to establish. The state of hydrology as a discipline, as well as the USACE experience, supports confidence in estimates of the effect of alternatives on river heights and velocities. Conversely, the emerging state of restoration ecology and the USACE's limited experience in environmental planning may mitigate against unquestioned acceptance of models that predict the effects of water levels on mallard duck populations.

Element 4: Formal Valuation of the Alternatives

Valuation is expected to determine the "worth" of achieving different levels of the planning objective (Element 2) for comparison with the costs of the alternative. Calculations that are part of formal valuation often employ abstract aggregation standards such as economic efficiency or environmental biodiversity. For example, the effects (Element 3) of alternatives on the planning objectives (reduced flood heights and velocity, increased navigation capacity and improved recreational duck hunting) might all be evaluated in monetary terms and added together. Such abstraction permits the combination of incommensurable effects into a few indicators of project worth. More than one aggregation protocol might be used to represent different dimensions of project worth. The presumption is that information reported in the evaluation accounts informs decision makers who then may determine the "public interest" merits of alternative plans.

The USACE has adopted the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) as a multiobjective evaluation system. The evaluation of project effects can be represented in four accounts, although only a national economic development (NED) analysis is required by the P&G.

The *NED account* reports measured changes in the economic value of goods and services. The NED account is the home for monetary valuation of restoration outcomes using the standards given by neo-classical economic efficiency theory. However, the NED analysis is limited to those outputs that can be measured in monetary terms in a manner acceptable to decision makers (see below). If an outcome is not amenable to monetary measure, the outcome is measured in another account. NED measurement is typically applied to outputs such as flood control and navigation. However, even for these outputs the NED evaluation is recognized as only a partial representation of project worth. For example, avoided damages to real property is the NED measure of flood control benefits, but that measure is recognized as being an incomplete measure of the full benefits from a project (Shabman and Stephenson 1993; Shabman and Thunberg 1992).

The *RED account* (regional economic development) also may include effects measured in monetary terms. However, the RED account uses value measurement concepts as employed in national income accounting, such as employment changes, changes in cash income and wealth by economic sector, and fiscal effects.

The *EQ account* (environmental quality) allows the planner to aggregate and report changes in general ecological indicators (e.g., biodiversity), as well as cultural and aesthetic attributes. This account and the OSE (other social effects) account are the home for nonmonetized effects of an alternative. The *OSE account* reports changes from perspectives that are relevant to decision makers, but are not reflected in the other three accounts. Thus, the effects on income distribution, environmental justice and the like might be recorded.

THE NEW PLANNING ENVIRONMENT, PLANNING ELEMENTS AND ENVIRONMENTAL RESTORATION

Planning Objectives for Environmental Restoration

The statement of planning objectives demands that there be some definition of desired changes in the state of the watershed to be achieved by restoration. Specifically, restoration planning requires a definition, in measurable terms, of the outputs of a restoration action. A watershed perspective should be adopted for defining restoration outputs (National Research Council 1993). First, the structural features and processes of a watershed would be described and measured. Physical features (acres and cover types of uplands, wetlands, and riparian zones), chemical features (ambient measures of sediments, temperature, dissolved oxygen, nutrient concentrations and the like in surface and ground water), and biological features (plants and animals within the aquatic environment and related lands) give rise to watershed processes. These processes include soil building, nutrient cycling, carbon storage and patterns and timing of surface and ground water flows. The interactions among features and process are complex and numerous. A wetlands position in the landscape may determine the timing and volume of surface water flows. Building of soil organic matter may increase water retention capacity, slowing run-off. The area between uplands and wetlands may determine waterfowl reproduction capability. Nutrient cycling may determine oxygen levels and in turn fish species composition in a river. At any time, a watershed's features and processes in relationship to one another yield a vector of watershed services which may be valued by people.

Table 1 includes illustrations of four classes of watershed services, all of which may be achieved through environmental restoration. Use of the environment as a production input and for direct use most closely aligns with the types of services that were the focus of the traditional water development programs. In those programs, these services were expected to be captured or enhanced by the construction of water control works. Restoration alternatives may reverse the effects of control works, but may still provide some of the traditional services. For example, wetlands re-creation may reduce downstream flood peaks and permit more intensive land use downstream. The waste assimilation services may be used by intention, but often use is simply the inevitable result of human activity.

Several points about the life support service should be noted. First, this service may be diminished by use of the environment for waste assimilation (e.g., by stressing the nutrient cycling capacity). This service also may be diminished by alteration of the watershed to secure production inputs and for direct uses. Second, the life support services are often intermediate inputs to the other services; nutrient cycling capacity yields the waste assimilation service, the habitat service supports commercial and recreational fishing, the hydrologic regulation service supports the ability to occupy lands that might otherwise be flooded. In general, many of the services at the bottom of Table 1 support services nearer the top.

Many restoration advocates feel that life support services have been diminished by past alterations to watersheds and by the use of the waste assimilation service. Further, they assert

TABLE C-1
WATERSHED SERVICES

PRODUCTION INPUT FOR MARKET VALUED GOODS AND SERVICES

- Transportation
- Power generation
- Land productivity for food and fiber production
- Water input in commercial and industrial production
- Land productivity for commercial and industrial purposes
- Harvest of commercially marketed fish and wildlife

DIRECT CONSUMPTIVE AND NONCONSUMPTIVE USE

- Recreation
  - Bird watching
  - Fishing
  - Etc.
- Municipal and home water supply
- Aesthetics

WASTE ASSIMILATION

- Processor or sink for human waste products
- Trap for eroded soil

LIFE SUPPORT

- Hydrologic regulation and attenuation
- Global carbon budget
- Water quality
  - Aerobic and anaerobic processes
  - Nutrient cycling
  - Sediment trap and export
- Habitat (food chain, nursery, etc.)

that restoration alternatives to enhance the life support services will also improve many of the other services in Table 1. Mimicking a historical pattern and timing of river flows or re- flooding an area that used to be a wetland are examples of restoration alternatives. Restoration alternatives usually are formulated with reference to a historical template, or to a similar watershed which has had less alteration, but for which there is some evidence that, at a prior time, the reference watershed and the target watershed were similar. In all cases the restoration alternatives are expected to yield some vector of the services listed in Table 1, the services being the restoration outcome. *The desire to enhance life support services motivates the current emphasis on environmental restoration alternatives, however, such alternatives can produce the full array of services listed in Table 1.*

By some definitions, rnaration alternatives appear equivalent to rnaration outcomes. A National Research Council Report defines rnaration as "... the return of an ecosystem to a close approximation of its condition prior to disturbance" (National Research Council, p. 18). Such definitions suggest restoration planning objectives can be an outcome where the landscape features structurally resemble a past condition. To accept this view means that the production function between the alternatives and services need not be precisely specified; if the past is re-created, then the life support services will follow.

At the large watershed scale, the Everglades restoration effort illustrates these different ways to state restoration planning objectives. One approach is to state the restoration planning objective using the services listed in Table 1. For example, the planning objective might be to increase the wading bird population. In this case, analysis of the determinants of wading bird populations may be necessary in order to develop the full range of alternatives that will serve that planning objective at the Everglades scale.[16]

Alternatively, the statement of planning objective may be to re-establish the features of the historical Everglades, in whole or in part. If the structural features were re-established, many desired restoration services might follow. Following this logic, the problem situation might be that water diversions have altered the historical amount and timing of sheet flow. The planning objective then becomes to return the diverted flows in ways that reconstruct the historical hydrologic regime at each remaining space in the original Everglades. If one half of the original Everglades area remains, then the planning objective is to mimic the past hydrologic regime on that half. As a planning objective, the closer the restored hydrology is to the historical, the better.

Another possible statement of the planning objective begins from an analysis that describes the Everglades problem in multiple dimensions of reduced spatial extent, reduced sheet flow, and reduced diversity of wetlands types. This problem assessment may lead to a planning objective to re-create, but in reduced size, the multiple features of the historical Everglades. The planning objective to recreate a microcosm of the historical Everglades presumes that scaling down of each element of the historic Everglades to fit into the remaining space will best assure the return of the life support and other services.[17]

If the planning was for watershed areas smaller than the whole Everglades, the identification of the planning objective is not made any clearer. Again, with reference to the Everglades, the planning objective may be to recreate bird nesting opportunities by the removal of fill material in a waterway. This objective is tied to the services listed in Table 1. Alternatively, the planning objective might be to re-create some limited number of acres of sawgrass marsh. This planning objective is an effort to re-create the structure of the ecosystem.

Restoration planning objectives may be measured either by the level of certain watershed services valued by people <u>or</u> by descriptions of structural watershed features. Ultimately, the decision to bear a cost for a restoration alternative will be expedited when the decision makers understand the different states of the watershed that will exist with, versus without, restoration. The planning objectives must therefore be credible to, and understood by, decision makers. Acceptance

[16]Of course, the multiple services of the Everglades may not be adequately represented by wading bird numbers. Indeed actions to increase wading bird numbers may at some level reduce other services.

[17]Additional discussion of this example is included in the next section.

and understanding by decision makers is a valid reason for selecting any particular definition of the planning objective.[18]

Formulating Restoration Alternatives and Measuring Restoration Effects

Alternatives are engineering, regulatory and other public policy measures expected to address a planning objective. The purpose of plan formulation is to define those alternatives that will serve the restoration planning objective. This must be followed by an estimate of the contribution of the alternative to the objective. Consider an alternative of re-creating sawgrass marsh in the interest of wading bird numbers. The creation of the marsh would be one of several alternatives ways that this service of wading bird numbers could be obtained. Perhaps another alternative would be placement of artificial nests.

If a vector of services is the planning objective (e.g., wading bird population numbers), then the definition of alternatives and their effectiveness becomes complicated. This can be understood by recalling the production function analogy made earlier. The features of a watershed system may be thought of a physical input which, in combination with human management inputs (the direction of energy, materials and know-how to the watershed), gives rise to a vector of outputs (services). To measure the effects of alternatives requires the technical ability to trace back from the level of the services to the contribution of the alternatives. The absence of a well defined "production function" relating all the services to management alternatives is a formidable barrier to effects measurement. Restoration ecology has yet to make much progress on models to estimate such effects (National Research Council 1993).

A different planning approach is to accept an assertion that "putting it back the way it was" will return some level of lost life support services. In this case the creation of sawgrass marsh itself is the stated planning objective and the alternatives become the different techniques by which such marsh can be created. The effectiveness of saw grass marsh for bird population support is relegated to a lesser concern with attention placed on the effectiveness of techniques for marsh creation and restoration. This approach leads to an overlap between restoration planning objectives and restoration alternatives; indeed, the planning objective and the alternative become indistinguishable.

However, what does it mean for a restoration alternative to re-create a past condition? Consider the Everglades planning effort once more. One viewpoint is that the appropriate alternatives are those which preserve the remaining landscape and just return diverted water back to these preserved areas. The remaining system is expected to evolve into a self-sustaining watershed.

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[18]As the cost of restoration alternatives increases some decision makers will expect analytical evidence of the link between restoration of watershed features and restoration services. For example, there is now much uncertainty about how river flows affect downstream salmon passage around the Columbia and Snake River's dams. Advocates for expanded fish passage are anxious to pass water over the spillways, rather than through the turbines of the dams, because they assume this more natural flow will improve fish survival. Opponents of the plan argue that without more compelling evidence about the effectiveness of the measure the foregone power benefits from this trial are too high. The issue remains unresolved.

A different perspective is that the Everglades has lost much more than water. There has been a reduction in spatial area and in the diversity of wetland and upland types. There is no prospect of regaining the spatial area of south Florida that was once the Everglades, so the only alternatives for restoration are those where management finely controls water flows and levels and assures a historical balance between wetland and upland types, all within reduced in areal extent.

The point here is not to recommend the appropriate Everglades restoration alternatives, but the lesson is clear. *It will frequently be difficult to obtain a consensus among decision makers on defining restoration alternatives. Agreement on how to measure the effectiveness of alternatives in serving the planning objectives is also elusive. This suggests that the USACE must conduct the plan formulation element with an openness to the interests and concerns of decision makers.*

The P&G includes among the criteria for plan selection, "acceptability." A key determinant of acceptability is the ability to compensate losers from plan implementation. In the past, management of a reservoir for a striped bass fishery, or for cold water releases to create a trout fishery, might have been offered as compensation (mitigation) for fish and wildlife losses imposed by the project. In this same manner attention to loss compensation will now be needed in the formulation of restoration alternatives. Thus, a wetlands restoration alternative might include purchase of farming or development rights from landowners. *The complete formulation of the restoration alternative might include compensation to those who must forgo the benefits of existing water and land uses.*

A third requirement is to expand the scope of alternatives beyond those related to water resources engineering at the site. USACE planning has often paid too little attention to alternatives that it had no authority to implement. For example, freeing up water rights markets and power marketing arrangements to synchronize the flows of water and the passage of anadromous fish might be an alternative to modifying the structure of dams in a river system. As another example, changes in the sugar import quota system might be an alternative to influence agriculture's effects in the Everglades. *For restoration planning, the range of alternatives must be quite broad. Therefore, the USACE planning process must explore partnerships with other agency programs and polices in order to formulate a comprehensive array of restoration alternatives.*

Formal Evaluation of Restoration Alternatives

The USACE draft planning guidance requires that evaluation of restoration alternatives be based on incremental opportunity cost analysis. Incremental analysis displays and justifies costs (financial outlays and forgone NED benefits) which are incurred to satisfy increased levels of the restoration planning objective. Conceptually, the formal analysis develops a marginal cost function with the level of achievement of the restoration planning objective on the horizontal axis and costs of the restoration alternatives measured on the vertical.

At present, the incremental cost evaluation requires three types of information: (1) indicators of change in meeting the restoration planning objective for development of the horizontal axis, (2) measures of the net NED opportunity cost of different levels of achievement of the planning objective for the cost axis, and (3) evidence that the proposed alternative is incrementally justified. In these gõidelines, justification for a restoration alternative need not include monetary valuation of all outputs. For restoration projects, the USACE planner is asked to establish the incremental costs of achieving different levels of outputs from a restoration alternative.

Monetary valuation of restoration outcomes (satisfaction of the planning objective) using nonmarket valuation methods is admissible as information in justifying a restoration alternative, but is not to be the determining factor. Using the marginal cost information "nonmonetary," as well as monetary, arguments are to be employed in argõing for incurring the increasing costs associated with the arrayed restoration alternatives.

The incremental opportunity cost framework is especially well sõited to sõpport restoration decisions made by negotiation. One example illustrates the role of opportunity cost logic outside the USACE. The Federal Energy Regõlatory Commission (FERC) reviewed the choice between foregone hydroelectric power and fish restoration potential from removal of two dams in the state of Washington. A United States General Accounting Office (GAO) report on the FERC effort noted that, "Because of the absence of generally accepted methodologies, FERC staff did not attempt to assign dollar estimates to nondevelopmental values such as fish production, recreation use, terrestrial resources, or aesthetics." The FERC analysis did include an estimate of the cost of dam modification and abandonment, as well as the power benefits foregone (measured as the cost of replacing lost power currently generated at the dams). The GAO observed that, "Given that the costs and benefits of various alternatives could not be fully quantified, we believe that the selection of one alternative over another is essentially a public policy decision in which value judgments must be made about the costs, benefits, and any tradeoffs."

Indicators of Change in the Planning Objective

Restoration planning objectives may be multidimensional, but ideally the degree to which these multiple objectives are achieved by a given alternative is measured by a single indicator. This single "state variable" (measure of the watershed condition) would then vary with each alternative. The appropriate set of indicators for restoration outputs in any situation is established by the way the planning objectives are established in planning Element 1.

Reference to historic conditions and to comparable, but less altered, watersheds is the basis for selecting restoration indicators. However, beyond this simple gõide, little more can be said. As the NRC notes about restoration planning, "... selecting an appropriate subset of indicators from the universe of possible indicators is a skill and an art - in essence, a separate decision problem that is of great importance to the feasibility, cost, and validity of the evaluation" (National Research Council, p.66). The tool of the oral history may aid immeasõrably in executing this planning element (Willard, this publication). *In USACE planning, the decision about indicators is made when planning objectives are written and accepted.*

If the planning objective can be narrowly proscribed to a target species, either as an objective or as an indicator of multiple restoration objectives, then the Habitat Evaluation Procedure (HEP), or any of its derivatives, might be used. HEP relies on describing features in a watershed, as they are necessary for the support of a particular indicator species. HEP scores called HSIs, or habitat suitability indices, may be computed for different species, but there is no acceptable way to unambiguously aggregate different scores into a single index. Increases in HEP scores with a given alternative indicates unambiguous improvement in meeting the planning objective. The HEP indicator has wide acceptance in the USACE and has recently been used to illustrate the incremental cost analysis process.

However, a single species habitat index may not be an acceptable indicator for the restoration planning objectives. One alternative is to use a measure of a watershed features (for example, acres of wetland of type X in location type Y). There are a few generalities that suggest how a change in watershed features would be positive. First, the ecological value of any alternative increases with the area of restoration. Increasing area supporting additional species and diversity and heterogeneity is the key to ecosystem resilience and persistence. Second, given that restoration will occur only in limited areas with human development at the boundaries, a project area that is insulated from deleterious effects at that boundary is preferred. Third, related to the area criterion, is the corollary to minimize fragmentation through corridors that connect patches of landscape which are restored or have not been substantially altered. This allows species migration and the opportunity of plants and animals to move about the landscape in order to survive external perturbations to the system by man or natural forces.[19]

Net Incremental Cost

The USACE draft evaluation guidelines require estimates of the change in net costs to the national economy (forgone NED) of meeting increasingly greater levels of the restoration planning objective. Foregone NED costs include financial outlays made by all governments and by individuals in implementing the restoration alternative. Also, the NED opportunity costs (forgone benefits) from the restoration alternative are to be included in NED cost. Estimating such costs requires running the NED analyses "in reverse" as services are lost rather than gained.

Recall that the P&G states that the NED account values the changes in watershed services (positive and negative) in monetary terms. In Table 1, four classes of watershed services were listed: a production input for market valued goods and services, the provision of direct services to users, waste assimilation, and life support. Moving down this list the services become more closely associated with the life support services associated with restoration alternatives. Economists have developed tools that may be used to place a money (NED) value on each of these services. Therefore, should all the effects of an alternative on the services in Table 1 be measured in NED monetary terms?

[19]In this case the planning objective is stated in the same terms as the indicator, so the role of the indicator, to synthesize a multi-dimensional output into a single scale, is not achieved.

Services such as transportation, power, flood control, drainage, commercial and industrial water, municipal and home water supply, irrigation and site-based recreation are traditional outputs of USACE projects. These services are directly used by humans, are closely tied to market processes either because they are traded in markets, are a substitute for a service that is traded or are a production input to a good or service having a market price. By reference to market data the evaluation in NED terms appears to command some acceptance. The NED measurement tools include cost of the next best alternative, the change in net income approach, the land price comparison approach, and the travel cost approach.

For many years the application of the tools by USACE planners has been the subject of criticism, usually by those who oppose a particular project and claim that the calculations were done improperly. The USACE has developed extensive guidelines on the proper approach to benefit and cost estimation. However, there is another dimension to the criticisms of a NED estimate. NED calculations which are rooted in a pure economic efficiency logic may be rejected by some decision makers for being an incomplete value measure or for being an inappropriate measure of the values gained and lost. For example, flood control benefits are measured by the USACE, following NED logic, by the technique of property damages avoided. The NED results might be rejected by some decision makers because nonproperty effects such as reduced anxiety over flood threats are ignored, because the poor are ignored (low income people have little property) or because the calculation ignores the possibility that the flood risk inhibits the development of a community's economic base. If the NED calculation is not accepted by the decision makers for the project, then its contribution to decision making will be neutralized.

Perhaps the most dispute over money measurement arises when the service is valued using what are termed direct, or survey, methods. This form of valuation, called contingent valuation (CVM), seeks values from individuals by asking them directly what they would be willing to pay for a change in the state of the watershed. The answers are hypothetical in the sense that the response does not result in an actual payment being made. Of course, in this sense the CVM is analogous to the property damages avoided approach used in flood control benefit estimates. The avoided damages estimate is a hypothetical amount people ought to be willing to pay for flood damage reduction. What differs with the CVM is that there is no market reference of any kind while avoided damage calculations are grounded in some market and hydrologic information.

However, if an NED price is to be put on nonuse recreation and aesthetics or on people's values for the life support services of the watershed—the services most identified with restoration alternatives—CVM is the tool that is available. While there is some academic support for the application of CVM in the P&G framework (Zilberman 1994), professional and decision maker skepticism continues to greet CVM estimates. (See Exhibit A. Also see Schkade, Appendix B, and Russell, Chapter II). Therefore, the USACE does not require that a monetary measure of "life support" services of a restoration plan be a part of the NED calculations in the incremental cost framework. *If use of CVM generates controversy rather than agreement, it should be used only when decision makers are willing to accept the validity of its results within the negotiation process (See Exhibit B). In general, the USACE planner should follow a simple, but admittedly ambiguous, guideline when deciding whether to measure any service in NED terms: measure services in NED terms whenever such measurement will be accepted by, and used by, decision makers.*

Justification

The USACE budget process requires a justification statement organized around the incremental cost analysis for allocating federal funds among competing project proposals. The justification statement should demonstrate to decision makers why the costs for the recommended plan are "reasonable." In the past, one piece of evidence that costs were reasonable was the reporting of positive net benefits (NED). Indeed, if decision makers will accept full NED valuation of all services, then the incremental cost framework collapses into a requirement to do a NED based benefit-cost analysis. On the other hand, if a restoration project is not expected to measure its outputs in an NED metric, then the planner must document her/his judgment that the "benefits" from the improvements in the restoration planning objective are in excess of the costs. *This justification must be made to convince those who can block or advance a restoration alternative about the merits of the project. This means that the analysis required for justification can only be determined after determining what will be acceptable to the relevant decision makers.*

Evaluation for Justifying "Small" Projects: A small restoration project is defined here as one which does not "substantially" reduce existing benefits now realized from the watershed. In the case of a USACE project, the benefit stream from the project would be unaffected[20] and only modest financial outlays would be required to implement the restoration alternative. The opportunities for this type of decision making may be numerous, but the restoration outputs will be limited for any case.

For small projects, the USACE may employ any internal planning and budget decision rules it feels are useful for setting priorities (establishing the reasonableness of cost) among this group of small projects. The need is to provide adequate and acceptable decision making information for the budget authorities in the USACE hierarchy. An NED based justification might be required, even one using CVM estimates of life support services. If all restoration services are valued in standardized NED terms comparisons across projects may be made more easily. However, the costs to complete such valuation studies may not be warranted by the project costs. Emerging concepts of "benefits transfer" might be adapted to develop “look-up” tables of monetary values (as with the unit day recreation values) for the smaller projects. Guidelines on how to use such tables would also need to be developed.

Evaluation for Justification of “Large” Projects: A large project is one where opportunity costs are imposed on decision makers outside the USACE. Agreement can be supported by careful assessment of the opportunity costs borne by decision makers adversely affected by a restoration alternative so that compensation strategies can be incorporated into plan formulation. When calculation of opportunity cost is to serve a negotiation process, the calculations necessary will be determined by who is represented in the negotiation and by who might have power to block a decision

[20]The prospect for this type of situation motivated the USACE Section 1135 program, where the presumption was that environmental outputs could be increased from re-operation of existing projects without infringing on existing project purposes.

even if they are not a party to the bargaining. These groups must be identified, their concerns understood, and then the costs imposed on them from each alternative should be clearly identified.

Frequently, analysis which describes such effects as changed revenues to affected businesses, changed prices for consumers, and changed job and income consequences for a region may be important for decision making. Therefore, there will need to be a new priority given to evaluation within the RED and OSE accounts if multiple decision makers' concerns are to be considered adequately in the analytical phases of planning.

BEYOND CALCULATION AND TOWARD AGREEMENT

The USACE planning process is conducted to support reaching of agreement among decision makers, an agreement that leads to project implementation unless the agreement is to take no action. Implementation means that necessary funds are allocated and that no legal or political action blocks the decision. The USACE planning elements facilitate restoration agreements. A facilitator helps groups make tradeoffs between restoration objectives and costs. In the future, for most restoration projects, planning will be focused as much on building external agreements on the "value" of the preferred alternative as on documenting value through computations called for by the agency budget authorities. *The USACE planner will need an understanding of challenges for building agreements as much as an understanding of the tools for analyzing data.*

One challenge will be to determine who should be part of the negotiation process. If some groups are not represented at the negotiation, then negotiated restoration decisions may be neither "equitable" (despite the making of compensation payments) or effective in reaching agreements that will lead to implementation. For example, a negotiated decision for an alternative to increase the salmon runs on the Columbia River that does not include native American interests might not yield an equitable decision or be implementable. However, what interests should be part of a negotiation and what role might they play? Public choice theory from economics describes the increasing decision making costs (decision making delays and financial costs) as group numbers increase. Also there is a decreased likelihood of reaching agreement as group size increases. However, if excluded groups have ways to influence the decision outcome outside of the negotiation, then their exclusion may serve achieving a group consensus on a preferred alternative, but will not assure that the preferred alternative can be implemented. The public choice literature, as well as the literature on environmental negotiation and alternative dispute resolution, includes numerous studies and recommendations about how this dilemma might be addressed through different forms of group decision rules, through the different roles that might be played by the convener of the negotiation (facilitation, mediation and arbitration), through the legislative actions to constrain the opportunities for opposition, and through different rules for the distribution of project costs.

A second challenge will be to communicate the essential analytical findings of the planning elements. Given the scientific uncertainty and room for different views for all of the elements in restoration planning, the ability to accomplish rapid "what if" simulations of different technical and data assumptions will help participants to agree on the planning objectives, on the alternatives that might be formulated and on effects of the alternatives on planning objectives and on their particular social and economic interests. In this way, tradeoff analysis can be rapidly accomplished.

CONCLUSION

Restoration planning for the USACE still poses the traditional planning question—are the costs of an alternative warranted by the values received? In the USACE tradition, this question was answered by relying on calculations made by planners for the budgetary authorities of the agency. The challenge of doing these calculations is now being replaced by the challenge of building agreements on what costs for achieving restoration planning objectives are "acceptable." Such planning for the USACE will demand identifying the “relevant” decision makers, determining what technical analysis is needed to support decision making and then communicating the finding of that analysis in a way that is useful for reaching agreements.

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EXHIBIT A
THE LOGIC OF MONETARY VALUATION

One objective of the EEIRP is to review the role of monetary and other valuation techniques for making environmental investment decisions. Attention to valuation is consistent with the USACE "benefit-cost" tradition. In developing the benefit-cost criterion in the last three decades, the USACE has adopted the prescriptive efficiency logic of neo-classical economics. Thus, the NED account establishes willingness to pay as the organizing principle for the estimation of value. The P&G then goes on to offer the USACE planner a variety of approaches to estimating willingness to pay benefits.

The valuation logic is well understood. First, monetary valuation efforts rest on two critical assumptions: (1) that individuals have and know their preferences (values) for goods and services (states of the world) and (2) that the preferences are revealed through market exchange behavior. Flowing from these assumptions is the result that market prices observed in a presumed equilibrium state provide the empirical data for preference (value) measurement. All buyers and sellers react to common equilibrium prices and equate their marginal utility for the traded goods and services to those common prices. Prices thus reflect individual, marginal valuations (marginal willingness and ability to pay). With the appropriate computational procedures marginal valuations can be used to derive economic surpluses for individuals. Total value measures are calculated by summing over the individuals' surpluses.

Indeed, establishing values for environmental services has become an interesting research puzzle for many economists because, for reasons generally subsumed under the term "transaction cost," market exchange prices for environmental restoration services fail to reveal marginal values. The research agenda and asserted policy need for *nonmarket* valuation rests on the market failure assertion. Values, or benefits, individuals hold for environmental outcomes are estimated as they would have been revealed if a market were able to achieve equilibrium under idealized conditions of exchange. Then, through benefit to cost comparisons, efficient allocations can be described and contrasted with inefficient allocations. Thus, many economists would argue that the USACE's restoration decision demands monetary valuation of restoration services to compare with restoration costs.

Nonmarket value estimation relies on either (1) revealed or (2) hypothetical choice techniques. Revealed choice techniques interpret market prices paid or received for goods or services which are related to some measure of the environment. Land prices near polluted and clean bodies of water are compared using hedonic price analysis. The travel costs to a recreation site are probed for evidence about the value of the site. Recent valuation studies have used purchases of insurance, substitute goods (e.g., bottled water), subscriptions to magazines and memberships in environmental organizations to estimate environmental values. Other studies have analyzed voting behavior and wage differentials among occupations to secure value estimates.

Hypothetical value techniques use surveys instead of market prices for related goods. These survey methods, generally termed the contingent valuation method (CVM), are constructed to elicit individual expressions of willingness to pay for alternative states of nature (which might be considered to be changes in the stated planning objective), under the assumption that the survey instrument has been carefully designed to mimic a "real" market choice. Thus, the CVM method might elicit citizens' willingness to pay for more wading birds at a location in the Everglades or the willingness to pay for increased sawgrass marsh in the Everglades, since either of these planning objectives represent a different state of nature.

Economics research has sought to perfect the nonmarket techniques by developing methods to assure that the simulated market was similar to a real market. Hence, the valuation literature has focused on matters such as (1) assuring the information structure in the simulated market is similar to a "real" market, (2) accounting for partial versus general equilibrium adjustments in markets and by individual households, and (3) guarding against biases that will cause individuals to overstate or understate "true" preferences. Without an actual market exchange there is no obviously correct verification protocol. Therefore, one popular theme of the professional literature involves attempts to verify the accuracy of value estimates. Of course, standard debates over sampling and econometric estimation are also part of this valuation literature.

Despite decades of research, the tools, especially CVM, are still viewed as "experimental" and debate over their utility and the validity of the estimates may be more intense now than at any time in the recent past. Neither this appendix, nor this report, is intended to be a comprehensive review of the technical issues in doing nonmarket valuation. Such reviews can be found elsewhere. A useful summary of the debate over CVM can be found in Portney (1994), Hanemann (1994), and Diamond and Husman (1994).

EXHIBIT B
VALUATION AS AN AID TO NEGOTIATION

The perspectives on nonmarket valuation offered here are methodological and historical. Both perspectives suggest that the purpose of valuation is to direct a value discovery process and not to establish value as a computational certainty.

Methodological Perspectives

Little in the nonmarket valuation literature questions the core assumptions of the research: that individuals know their preferences and can express them independently of choice opportunities, and that market equilibrium (which makes such estimations computationally tractable) exists as more than a convenient analytical assumption. Also, there is little serious concern within the literature that nonmarket valuation advances efficiency as a single best public decision rule. However, even a cursory review of the Austrian and Institutional economics literature should make economists uneasy about the benefit estimation research program.

An Austrian Critique: In the Austrian view, prices emerging from market exchange can not be used as a measure of value. Instead, prices are a historical record of a trader's circumstances (information, income, alternatives) and preferences at the time the price was established. The Austrian interpretation of the price a person was willing to pay for an environmental outcome in the past can not be used for establishing future values. People's values may change over time as people gain knowledge about, and experiences with, certain goods and services (such as restored natural environments) and, as a result, they may be willing (or unwilling) to pay more of their money income for those services. Also, the circumstances of the original purchase may have changed. Preferences are discovered and revised through market exchange.

An Austrian argument against valuation through interpretation of prices follows from their conception of the role of market exchange as a social organizer. Formaini (1990) states that in the neo-Austrian world, equilibrium never exists at the level of the market and is only a temporary state for individual market traders. Market prices encourage individual entrepreneurial adjustments as people continuously redefine their preferences and search for new technologies. Klamer and McCloskey have put it this way:

> The problem in economic life is not calculating what to do after knowing all that you need to know. The problem is to know... The Austrians see the economy with the metaphor of fog, the fog in which we maximize what the neo-classicals so confidently describe as 'objective functions' ... the main problem is acquiring knowledge, not exploiting it.

Attempts to read preferences (values) from choices made in this "mist," as is required in the nonmarket valuation research program, is a puzzle solving activity where the puzzle solution has no meaning outside the abstract solution rules given by the market equilibrium analytical framework.

An Institutionalist Critique: Still the advocate for nonmarket valuation may ignore this critique and continue to promote the results for use in a net benefits analysis to direct restoration spending and regulation choices. The net benefits criterion is a guide to efficient public policy; that is, the policy that would emerge from a perfectly functioning market if that market were able to function. Here is where an institutional economics critique of nonmarket valuation would apply. The institutional economist argues that nonmarket value measurement inappropriately elevates the preferences of current individuals and the power system (property rights that establish ability to pay) in the economy to the touchstone for environmental decision making. However, the essence of public policy discourse is to redistribute power and to form new values, in this case for environmental restoration services. Within institutional settings of culture and power, preferences are continuously created and are not fixed parameters to be measured by research economists (Hayden 1993).

Institutional economics reminds us that the discovery of *instrumental value* is the primary purpose of our public policy processes. Instrumental value is not a precise concept, but it recognizes that interests of the community in, for example, the life support services of the environment, can be distinguished from the simple addition of the measured preferences of isolated individuals in nonmarket valuation exercises.

Implications of the Methodological Critiques: The primary difference between the Austrian and Institutional critiques is the institutional economists' discomfort with the methodological individualism of the Austrians. The Austrians study and predict the outcomes of individual "free" (purposeful) choice and they are not willing to challenge the existing institutions of power and property which "weight" each individual's influence in a market, or market-like, system. In offering alternatives to nonmarket valuation, the Austrian would advocate design of market-like bargaining systems that mimic the search and discovery power of the market and find "optimal" allocations as the simple summation of the preferences of individuals.

Institutional economists argue that market and market-like choices are not free choices. Also, for the Institutionalist, a market-like organization can not, by its structure, adequately represent the "instrumental value" of natural systems. Instrumental values are best discovered in an open social/political dialogue that recognizes power and information differences when society sorts out the values that should count.

Despite their sharply contrasting views, the two criticisms both lead to some form of negotiation and bargaining system as the basis for environmental restoration choices. Practitioners of environmental policy must somehow learn from both points of view in improving the design of the current approaches to negotiation over environmental restoration.

At present, there is a tendency to accept negotiation-based restoration decisions as equitable, because compensation for losses is made. These same decisions might be deemed economically efficient, much as we presume voluntary exchange relationships in markets yield efficiency. However, skepticism should always be expressed about the efficiency and equity of any negotiated outcome. In fact, this skepticism is also grounded in the Austrian and Institutional economics traditions. The

Austrian (Public Choice) economist will remind us that negotiated restoration decisions have the potential for cost shifting. A decision to accept or reject a restoration plan might be optimal for the parties to the negotiation, but impose a large cost on the society. The institutional economist reminds us that negotiated restoration decisions will not be "equitable," despite the distribution of compensation, if some interests are not represented at the negotiation or if there is an imbalance in the power to influence outcomes. Finally, an evaluation of the negotiated decision against some external, "instrumental" criteria (ideological assertions of proper values) may be necessary to judge the bargaining process.

An Historical Look at Benefit Estimation

The tradition of estimating benefits and costs (now NED analysis) in USACE may suggest that the computations of value are the key to the decision process. Such an inference would support efforts to measure environmental services in the NED account. However, an understanding of the contribution of valuation to decision making is not possible without reference to its historical and bureaucratic context (Shabman 1989). The early water resource development plans of the federal government were expected to show that the financial repayment requirements, where required of project beneficiaries, could be met. In these cases, a demonstration that it was financially feasible to use the project services (e.g., irrigation water) and earn income adequate to repay a share of project costs was all that was required. The 1936 Flood Control Act provided the first legislative admonition to federal agencies to conduct a comprehensive assessment of the benefits and costs of their proposed work.

However, to appreciate the context for that act, it is useful to go back to nonfederal efforts to ascribe benefits to projects before 1936. Beginning with the Mississippi River Commission in the late 1800s, and continuing to the planning efforts of the Miami Conservancy District of Ohio in the 1920s, benefits from reduced flood risk were estimated as the expected difference in land prices with, versus without, a flood control project. These benefit estimates were a starting point for negotiations between needed. Hence, for example, flood control benefits were computed as the present value of real property damages avoided (PDA). The PDA technique relied on the hydrologic information that was routinely developed for project planning. Also, the PDA approach had a compelling investment logic: if current expenditures for a flood control project were less than the present value of avoided future property repair costs, then the project was justified. However, the limitations were recognized by planners and decision makers alike, so PDA benefit estimates only were an initial screen to determine project worth. These benefit computations were not intended to be the final factor determining project choice. Therefore, in the political arena where project investment priorities were set, the simple calculations of PDA benefits were part of a broader consideration of the "nonproperty" effects that would be mitigated by the project.

Over time, the stringency of benefit computation requirements was increased and reference was now made to the emerging insights offered by theoretical structure of neo-classical welfare economics. Reflections of this literature appear in a sequence of federal water project evaluation guidelines. Many of these guidelines, while not using the term directly, implied that landowners' and society's "willingness to pay" for project outputs was the standard by which benefits should be established. However, the motivation for the development and transfer of economic efficiency logic to the benefit-cost requirements was not an intellectual commitment to economic theory. Instead, the willingness to pay logic was a vehicle for imposing a defensible new stringency on benefit estimation in order to exert hierarchical and budget control on the agencies, to be able to resist local "boosterism" in project support and, later, to advance an early environmental agenda (Carter) for diminishing the budget of the national water project construction programs. If there was a central decision purpose for benefit estimates, it was that the reporting of benefits was the beginning point for negotiations within the agency, and among the agency, local (congressional) project sponsors, and the administration budget authorities. Positive net benefits might get a project plan to the negotiating table, but they did no more than that.

As the national interest shifted from development to the most "intangible" services of the environment, economists developed CVM to measure willingness to pay benefits for environmental improvements. However, few of the numerous environmental laws of the 1970s provided a place for such information in the decision making. Despite the advocacy by some economists, nonmarket valuations have been ignored in decision making, except in one telling instance—natural resource damage assessment. This application fits well within the historical application of benefits assessment, where such assessments have always been as a starting point for negotiations on spending priorities by government. Today, natural resource damage assessment numbers are only a start on decision making negotiations between those liable for harm and government trustees, often with the oversight of the courts.

Implications of the Historical Perspective

The underlying premises and purposes of measurement have changed over time. However, even as the conceptual foundations for benefit assessment have shifted, the uses made of benefit estimates have been remarkably consistent. The role of benefit computations has not been to establish values, but rather to serve as a starting point in negotiations over value. This kind of negotiation went on when the value of drainage works was negotiated in the 1850s, and 150 years later value estimates are serving negotiations over the values lost when natural resources are damaged. To expect value estimation to be any more than another "argument" introduced into public deliberations is to ignore this history.

APPENDIX D
VALUATION OF RESTORATION PROJECTS

Dan Willard

VALUATION OF RESTORATION PROJECTS

- **Are there elements of projects that existing analytic tools do not describe?**
- **How should these elements be included in project evaluation?**

PROLOGUE

What is the problem?

1. The Corps of Engineers (COE) must decide which restoration opportunities to support. They have only enough money to fund the best projects. This leads to questions of what is "best." Project analysts seek a Best Management Practice or checklist solution to a comparison of restoration projects from a holistic standpoint. Others suggest that a cookbook solution is inappropriate.

2. The COE thinks that an ecosystem approach increases the probability of success. The COE believes in the restoration of "ecosystems," not just places. To the COE, ecosystems contain not only biological, physical, and chemical elements, but linking processes as well. Beyond that, some suggested that "the whole was equal to more than the sum of its parts." Given this holistic view, what is the difference between the sum of all the disciplinary analyses and the whole system? In that sense, the COE must decide how to evaluate the differences among various projects.

3. What is an ecosystem? What does it include? How can an ecosystem be managed or restored? This defines circle A found on page 2.

4. Economic analysis uses a dollar surrogate measure and public participation tools to count supporters of each project. Both approaches have some utility. The economic approaches merely view the sum of all in different terms. Public polling reflects popularity and population density of the projects under consideration, proper demonstration of the instantaneous political appeal.

5. These social science approaches raise two questions: Are there intrinsic values to ecosystems? Are quantitative measures really valid for social and intrinsic values?

6. Figure 1 uses a simple Venn diagram to help clarify the intent of this essay. The figure shows the area philosophically encompassed by the notion of an ecosystem. Note that the ecosystem boundaries themselves are subjective. Within that ecosystem (circle A), areas show the subsets of values covered by various fields such as economics (B), ecology (C), and social science (D). Other analytic tools are combined together under (n). The diagram shows

spaces within the larger circle A that do NOT fall in B, C, D, or n. This space is arbitrarily termed Z. Set A, defined by the encompassing circle, represents the ecosystem involved in a particular project. Its spatial and functional boundaries vary over time, space, and definition. The Z space is composed of various abstract material. These abstract notions frame the difference between the whole of A and the sum of all the parts. Sets B, C, D, and n all contain some risk and uncertainty.

Figure D-1 (Ecosystem) Could Not Be Reproduced Electronically.

ITEMS OF CONCERN

The Tyranny of Numbers

The tyranny of numbers often precludes the evaluation of attitudes, usefulness, aesthetics and intrinsic benefits of ecosystems. Each field of ecology, economics, and social research has developed quantitative techniques to characterize facets of problems. Some examples may clarify the limitations of quantitative manipulation and interpretation of data.

Ecologists have applied the principles of mass balance to material cycling through ecosystems. They use the concentration of nitrogen, phosphorus or potassium to classify bodies of water. Measurements taken from time to time, and place to place will vary. Analysis of these measurements can provide a very precise water quality number. While precise, this number contains uncertainties due to changing conditions and the vagaries of measuring devices. Scientists use a spectrum of statistical tools to differentiate the real effects from the measurement inconsistencies, short term spatial and temporal variations, and the chance vagrant sample. When several sets of data are used to predict trends in a complex system, subtle changes often become buried in the large volume of data.

While a long-term, detailed, and careful study contributes a great quantity of precise numbers, the study may not contain sufficient accuracy to capture general trends. However, this study, accompanied with some knowledge of the activities in the watershed, can predict the future general nutrient loading of the water body. However, without knowing the ecological history of the water body and past land use patterns in the watershed, this nutrient information has little management value. The concentrations themselves must be placed in a spatial and temporal environment to become useful.

The edges of economic analysis also appear vague, imprecise, and often inaccurate. Cost-benefit analysis of water development projects occurs with many projects. Economic analysis generally includes assumptions about the values of the project products and for the activities impaired by it. Because these water projects will last many years, the costs and benefits stretch over those years as well. The costs are preconstruction estimates, and overruns do occur. Analysts assume that the value of these costs and benefits will change over time, so they assume a rate of change of value, called a discount rate. Thus, this process assumes values and then multiplies them by an assumed rate. These assumptions are not entirely arbitrary. Usually, the numbers are taken from the assumptions of other similar studies. These cost/benefit studies often express their conclusions in a single ratio of benefits over costs, such as benefits exceed costs by 2.3 times. The COE has guidelines to suggest at what level projects are feasible. The go/no go ratio is also expressed to the nearest tenth, e.g., 1.8, 2.3.

Few studies exist which examine the validity of the assumptions of the water development cost/benefit studies of the last several decades. Several years ago, three cost/benefit studies of the development of the Tellico Dam project in Tennessee were conducted. One was done by TVA, one by GAO, and one by the opponents of the dam. Each assumed a different value for Snail Darters, for recreation, for Native American artifacts, and for local area jobs. Each assumed a different discount rate. The conclusions by the TVA showed a strong, positive ratio, the GAO showed the benefit/cost ratio about neutral, and the opponents calculated a negative ratio. There is no known subsequent report to determine which study was the most accurate.

A gambling consortium hired a public opinion consultant to find the demand for more gambling facilities. The consultant found that the average adult in the United States spent $200 each year on gambling. However, an informal survey conducted by this author revealed that few admitted to spending more that a few dollars a year. Therefore, it must be concluded that high rollers are skewing the average. When pressed about the details of the study, it was found that the consultants wanted to query respondents who were informed about gambling, so they conducted their study with passengers arriving in Las Vegas.

These examples show that accuracy and precision differ. They also show that the frame of reference and the bias of the person conducting the study affect the outcome. All studies evaluating complex systems always contain bias. These biases come from the training and history of the observer. The education of the observer affects the tools he or she uses. The *a priori* beliefs of the observer determine the conclusions.

On Classification Systems, Models, and Personal Bias

Classification systems and evaluation models all reflect the purpose and training of their creators. Several reasons exist for this often unconscious slant to the system. Usually critics make three points: (1) the system is too complex, (2) it takes too long to become expert, and (3) the classification and evaluation models do not include everything. Most wetland experts are familiar with HEP, WET, the 1989 interagency classification manual and the new Brinson Hydrogeomorphic Classification, so it is not necessary to go into the details of those systems here. These evaluation systems do serve as examples of the general phenomena discussed below.

A Protracted Wetland Example

a. In 1985, more than 50 different wetland definitions used by state federal and local government were collected (Willard, et al. 1990). These definitions served local regulatory purposes adequately. The increased emphasis on wetlands and real enforcement caused considerable conflict. When a definition became part of an active regulatory program, it quickly became the subject of adversarial proceedings. People who did not wish their property controlled by water statutes sought many creative ways to define their particular pieces of property outside the "waters of the United States." During the National Wetland Policy Forum, private property development groups continually tried to alter the national wetland definition to exclude properties in which they were interested. That caused a shrinkage of the actual property defined. <u>In summary, this objection is that many opponents of wetland regulation do not like any definition that affects them. They simply do not like regulation</u>.

b. Around 1990, many complaints arose claiming that the 1989 classification system, WET, and HEP were simply too difficult and costly to implement. To some extent, this complaint had its root in anti-regulation attitudes. It contained a new element as well. Lawyers and engineers had to depend on biologists for delineation and advice on mitigation. For project developers, this became a new cost. For lawyers and engineers, it became a new series of complexities from outside their fields in project development and construction; in short, a mysterious, nonprofitable, new impediment.

c. Opponents of wetland regulation also argued that a "simple landowner" could not identify the wetlands on his own property and, therefore, could not plan for future development. The "objective" evaluations concocted by the agency scientists require that the wetland professional consultant have basic knowledge of soils, hydrology and ecology.

What Do These Wetland Evaluation Systems Show?

Any of these evaluation systems will provide reproducible results no matter which side (of the issue) does the work. This replication depends on trained operators tempered by the adversarial system. Nonobjective experts can pervert any system. WET evaluators, wetland delineators, and HEP people must do their work openly so all parties can see the work. The evaluations would be more effective if they were done by cooperating multi-sided teams. The merits of the evaluation system are separate issues from whether any party gets what he or she wishes. In a sense, when we condemn these evaluation systems, we are merely killing the honest messenger of bad news.

The study of wetlands contributes an example of these considerations. The essential social and scientific characteristics of wetlands make them difficult to evaluate, classify, regulate, restore, or otherwise manage. Wetlands represent prime examples of controversial ecosystems. They inspire an intricate knot of intertwined social, economic, and scientific attitudes and concepts. Wetland definitions are social constructs conceived as regulatory levers to expand and institute the environmental views of one subset of society. All members of society do not hold these views.

Wetlands became part of the waters of the United States partly because of NRDC v. Calloway in 1975. Many wetlands remained on private property. In Wisconsin, Just v. Marionette Co. tried to split the public trust character of water from the private property powers implicit in the 5th Amendment. Some wetland definers have pushed the boundaries to expand the public elements, while others have defined the boundaries to maintain private property rights.

Wetland scientists themselves have individual preconceptions that confound the attempts at objective definitions. Others seek a consensus position, or at least, a majority position. Thus, wetlands become politically defined. Scientists, on the other hand, are confronted by a complex set of dissimilar, natural settings that change both in cyclic and noncyclic ways. Each has a unique set of conditions, yet some resemble each other more than others.

Wetlands and other watershed lands are closely interrelated. Therefore, it is difficult or impossible to evaluate and protect many wetland functions and values without also considering and managing broader watershed activities. The importance of external relationships is why it is so difficult to evaluate, classify, or otherwise manage wetlands in the abstract. In the lower 49 states, most wetlands and watersheds are modified by human activities.

The ongoing wetland debate illustrates this illusion of objectivity quite well. Consider the following syllogism:

a. The category "wetlands" is a construct of several kinds of ecosystems.

b. "Ecosystems" are constructs of natural parts and processes.

c. We know that wetland and ecosystem boundaries are continua that vary over time and space.

d. Thus, wetland delineation must be subjective.

e. Further, everyone tries to design a delineation system consistent with his or her own judgement.

f. Yet further, judgments are culturally and experientially conditioned.

Do Traditional Scientific Studies of Wetlands Help?

Three scientific characteristics of wetlands make them particularly difficult to delineate, evaluate, regulate, and restore.

a. Water levels and patterns of vegetation and habitat use fluctuate within certain ranges. Wetlands are, by their very nature, shallow water and high groundwater systems. They comprise both land and water. This combination makes them different from either water or land and gives them some special qualities.

   Wetlands are characterized by fluctuating water levels and many functions are dependent upon those fluctuations. Because of these fluctuations, the appearance of wetlands often changes dramatically from season to season and year to year, including water level and wetland vegetation. Unlike lakes, rivers, and streams, which have readily observable and definable boundaries, wetlands are often difficult to locate because of their fluctuation. Natural fluctuations in water levels due to seasonal or long-term precipitation cycles do not dramatically change the appearance or boundaries of lakes, streams, rivers, and the oceans. However, since they are shallow surface water and high groundwater systems with gentle slopes, wetlands are greatly affected by these fluctuations. Differences in water levels of inches due to normal fluctuations in precipitation or watershed activities may make the difference between "wetland" and "nonwetland," or dramatically change wetland plant species.

Fluctuating water levels have several implications. First, wetlands are not static or relatively static systems that can be delineated or classified based upon a single determination of existing water level or vegetation. Second, a "one-shot" view of wetlands based upon a single field examination of wetland hydrology at the time of a site visit cannot reflect values and functions, nor can it accurately reflect the hydrologic or other wetland characteristics.

Because precipitation varies throughout the U.S. not only seasonally and annually but with long-term cycles, a prairie pothole or other wetland may be wet year-round for two years, seasonally for the next five years, and then almost entirely dry for the following five years. For example, the recent drought in the West has demonstrated that the critical feeding and resting values of wetlands for ducks, geese, and other waterfowl depend not only upon seasonal wetness, but wetness in the "dry years" as well. A long-term as well as a short-term perspective on hydrology is required.

Wetlands do have permanence in the landscape and relatively certain boundaries when viewed from the long-term perspective. The fluctuations occur within relatively fixed limits. The key to understanding frequency of inundation is that it is not an absolute annual, every-other-year, or every-three-years event. It is periodic given the range of hydrologic conditions that occur within a given region or watershed of the country.

b. These fluctuations in water levels result in a combination of natural functions and natural hazards that are not readily observable to the landowner or even a trained scientist from the immediate appearance of a wetland or a causal site visit, particularly during dry periods. The relatively hidden nature of these functions and values and the costs of documenting functions and values are two of the reasons why wetland evaluation, classification, regulation, and restoration are so difficult, time-consuming, and expensive.

Intertwined Functions and Values

Wetland functions and values depend upon not only intrinsic characteristics of the wetland, but what happens throughout watersheds. Wetland functions and values and natural hazards depend upon what happens at other locations in the watershed for two reasons. First, watershed activities affect wetland water quality and quantity, which, in turn, determine all wetland functions and values. Second, many wetland functions and values are dependent upon the relationship of the wetland to other waters and land (i.e., its watershed and landscape context). For example, a wetland is usually important for fish spawning only if there is ingress and egress from the wetland to other water bodies.

Scientists generally distinguish wetland "functions" from wetland "values." Wetland functions consist of the biological, physical, and chemical processes of wetlands. The term "function" is also often used more specifically to refer to particular processes with potential value to man in producing goods or performing services such as flood storage or pollution control. For example, wetlands conveying flood waters from higher to lower points serves a flood storage and flood conveyance function.

a. Wetland functions are also dependent upon the relationship of the wetland to broader ecological systems. For example, the function of a wetland as critical habitat for particular plants and animals depends upon the relative scarcity of the habitat in the area. The function of a wetland for fish spawning depends upon a connection between the wetland and an adjacent water body. The function of a wetland as a wildlife corridor depends upon the connection of the wetland with other wetlands and open space areas.

   The function of a wetland often depends not only upon "absolute" wetness in the landscape but "relative" wetness. To understand the importance of relative rather than simply absolute wetness to functions and values, compare, for example, two areas: one along a river or stream in Louisiana and one in Arizona. Many of the "driest" adjacent lands in Louisiana with more than sixty inches of rainfall may be wetter than the "wettest" riparian sites in Arizona with less than ten inches. From a national or Louisiana perspective, these Arizona sites would often not be considered "wetland" except that they lack twenty-one consecutive days of saturation. But, from an Arizona perspective, they are relatively wet in comparison to the rest of the landscape. Because of this relative wetness, these lands are characterized by bands of vegetation (cottonwood, willow), which are extremely important habitat but do not meet obligate wetland criteria. Because of this "relative wetness" and location, they perform flood conveyance, flood storage, wildlife habitat, food chain support, stream bank stabilization, and, in some instances, pollution control functions similar to much wetter areas in Louisiana.

b. In contrast, wetland "values" provide economic benefits to man for these goods or services. For example, a wetland conveying flood waters from higher to lower points has a specific economic benefit to a house placed adjacent to the wetland. If the wetland is filled, flood waters will rise, damaging the house.

All of the factors relevant to functions are also relevant to value. In addition, value depends upon the relationship of wetlands to the specific needs of man. These needs differ geographically and over time. For example, consider the wetland that conveys flood waters in its natural state from an upstream to downstream site (flood storage and flood conveyance function).

In a rural setting, the wetland may have little immediate "value" to man if there are no buildings or other activities in the vicinity or downstream that may be damaged by the increased flood heights resulting from destruction of the wetland. However, if houses are built on the margin of the wetland, specific, increased flood damages would occur if the wetland were destroyed. The wetland would have a specific and quantifiable economic value for flood conveyance and flood storage. But this dependency of wetland value upon specific needs means that it is also very difficult to make a once-and-for-all determination of value because watershed contexts change over time.

The existing, specific "value" is often quite different from the future value. As development occurs in a watershed, certain values are typically enhanced—flood conveyance, flood storage, and pollution control. However, certain other values, such as habitat, may be reduced by pollution and cumulative impacts. Reasonably anticipated values are, therefore, best evaluated in terms of wetlands/watershed land use plans that project future uses and activities.

Mitigation

Many projects which require off-site mitigation use small creation efforts which are more likely to fail than large scale projects and are more costly to permittees. Often the Corps does not require full mitigation because they decide that losses from the project will be so small that mitigation is not practical from a cost/benefit perspective. As a result, there is a net loss in wetland habitat. Additionally, required creation projects are often begun concurrently with the project causing the habitat destruction. Creation or restoration of a functioning wetland takes time (five or more years) and has an uncertain outcome. At best, there is an interim loss of habitat. This forces already stressed species to move to other wetlands. If no suitable habitat exists, the interim impacts on the species will not survive.

Not all wetlands are equally valuable to man or equally subject to natural hazards. This has led to proposals to compare the values of wetlands to other wetlands (e.g., classify or rank wetlands for regulatory purposes). But, detailed, advance evaluation of wetland functions and values is difficult, time-consuming, and expensive. And, wetlands with little value may, nonetheless, be subject to severe flooding or other natural hazards.

Furthermore, comparative ranking of wetlands often has limited value in a regulatory context because it provides little information concerning the appropriateness of a prepared activity at a wetland site versus another site. The issue at the site of a proposed activity is usually the appropriateness of a particular use (considering values and natural hazards) at a wetland-versus-upland site and not a wetland-versus-wetland site. For example, a private landowner wishing to construct a house on a lot with a wetland must usually decide whether to put it in the wetland or on the upland rather than in one wetland versus another.

Restoration or Creation

Wetlands are highly diverse and complicated systems. The degree to which various wetland characteristics, including functions and values, can be restored or created varies. A distinction must also be drawn between what is theoretically possible (assuming unlimited funds and expertise) and what is actually occurring and will occur on the ground.

Based upon what we know scientifically, it is not possible to fully "restore" all aspects (e.g., soils) of natural wetlands in a relatively short time period, but it is theoretically possible to restore or create some wetland characteristics and functions. The problem, in part, is actual restoration and creation efforts have almost invariably fallen short of what is theoretically possible due to incorrect design, incorrect construction, or lack of long-term monitoring and maintenance. This is, in part, because traditional science has little ability to deal with holistic systems.

In general, restoration is easier and more successful than wetland creation. And, relatively large scale restoration or creation efforts by expert agencies (e.g., the U.S. Fish and Wildlife Service) with long-term maintenance capability have been much more successful than small scale efforts by private developers who often lack the expertise and long-term maintenance capability.

Some functions can be restored with proper engineering studies and project construction such as flood storage and flood conveyance, wave retardation, and erosion control. Others can also be restored in some circumstances such as fisheries, food chain support, pollution control, recreation, and certain types of habitat. But it is very difficult or may be impossible to restore certain habitat for rare and endangered species. And, the "biodiversity" value of many restored systems is also questionable.

Success rates and ability to restore also varies greatly depending upon type of area and the source of water. In general, salt marshes and others dependent upon water supply from adjacent lakes and streams have been restored with relatively high rates of success. It has been more difficult to restore shrub and forested wetlands due to their greater sensitivity to water depths. It has been even more difficult to restore freshwater, isolated wetlands dependent upon surface runoff due to uncertainties in calculating and projecting this runoff. Finally, it has been very, very difficult (with low success rates) to restore wetlands dependent upon groundwater.

On Uniqueness and Generalization

The confounding problem with comparing ecosystems arises from the contrast between these two statements.

1. Each place is unique.

2. Much of our traditional scientific knowledge about ecosystems depends on theory and generalization.

Therefore: While the patterns and processes existent at one place resemble those at another, the actual consequences of the local interaction may vary considerably from place to place. Natural history studies act to validate and calibrate the local applicability of the deductions from traditional science.

Uniqueness is in the mind of the observer. Experienced observers see greater detail and difference than remote observers. This sharp cognitive discrimination comes from years of concentration on a specific place or thing. For example, entomologists such as Paul Ehrlich and E.O. Wilson see thousands of different kinds of insects. The rest of us see only a few.

Natural historians, whether they are birders, fishermen, or wildflower aficionados have an intimate knowledge of place that general theory can never describe. They see uniqueness where others see similarity. In the afterword to *Cold Running River* (Willard 1994) I described the intimate knowledge of a long time river guide.

> This very concentration creates a philosophical paradox. The more we study a site to find similarities with other like sites, the more we notice the uniqueness of each site. As we attempt to find discrete sample sites, we find few sharp boundaries. The more we try to get a fair sample, the more nonrandom our sample.
>
> In scientific works, the method section often goes into considerable detail about how the investigator carefully set up his or her transect using this random number generator or this double blind technique. Many of these straight forward statements come from months of frustrating trial and error in which the investigator tries to get a method which gives logical results and fits the situation. He or she may have tried tens of different sampling systems and analytic tests before simply writing, " We analyzed our data with the Smith-Jones test. The results are provided on table whatever."
>
> Our laboratory for these studies is the Pere Marquette watershed. No hill looks like any other hill. Each bend has unique features. I have spent some time floating and fishing on the river between highway 37 and Gleason's Landing. I still get lost. But many people ... know the entire stretch so well that placed down blind-folded on any piece of the river, and the blind-fold removed, they would know their location within inches. Each place varies enough that an experienced person can recognize it.
>
> On the other hand, this same person, let's say a guide, if placed down in some place hither-to-unknown, on the Pere Marquette or any nearby similar river, would look around, muse, read the water and figure out where the fish ought to be and how to proceed. I suggested to Bob Nicholson [a guide] once that this first cast was simply an empirical natural experiment using a hypothetical-deductive model based on years of observation, induction and development of grounded theory. He snorted and commented on the absurdity of professors. But he did recognize that this place shared enough characteristics with other sorts of places that he understood its workings.
>
> Our problem then is to capture the elements of a place on the river with enough precision to understand its workings; then to understand the workings of similar places sufficiently to apply them across the landscape.

Risk and Uncertainty

Uncertainty and risk appear in the forms of ignorance, error, and stochastic events. Knight (1921) noted that "risk" can be quantified, "uncertainty" can not. Experts can calculate the reoccurrence frequency of floods, droughts and hurricanes. Complex soils and substrates cause uncertainty to groundwater hydrologists. Fast climate change makes the calculation of risks uncertain.

Decision trees using ecological risk assessment help understand the limits of applicability in these water accounts. For example, many biological systems are especially adapted to temporal and spatial variability in water regime patterns providing some potential to self-regulate within ecosystems. Many common sorts of wetlands are evolved especially in response to variable water systems. The ability of a watershed to regulate homeostatically depends in large part on the presence of wetlands in the watershed. Antithetically, watershed-wide disruption of the historic patterns of variability will perturb the wetlands throughout the watershed.

A lack of understanding about the self-regulatory properties of complex natural ecosystems frustrates ecologists' attempts to manage watersheds. The mechanical and stochastic properties of physical systems become confused with the adaptive, often counter-intuitive homeostatic processes of biotic systems. Many watershed/wetland systems require spatial and temporal variability of external stimuli to support the diversity of organisms which allow the system to adapt. They thrive on risk and uncertainty.

We have attempted to manage this disconcerting inconsistency out of the system. In the process of making watersheds predictable and consistent, we have lost the biotic parts. Nonliving systems just do not adapt well.

A SUGGESTION

Narrative, ecological history studies provide comparisons of intrinsic features of ecosystems. Ecological histories combine the elements of classic natural history, journalism, scientific history and oral history to describe a place. These naturalistic methods best show the intrinsic ecosystem relationships such as biodiversity, patch dynamics, and landscape relationships. These studies incorporate the activities and consequences of human management of the place as well.

The Limitations of Natural History

Natural history studies describe the place and report on the occurrences there. Generally, pattern and process emerge because the observer has concentrated on a particular place or thing over a long period of time. Many of such studies exist: John Wesley Powell's *Exploration of the Colorado*, Murre's *Naturalist in Alaska*, Austin's *Land of Little Rain*, and many others. Because these studies reflect the natural passage of time and season and report only what the observer has the attention to see, they require years and often decades.

The soul of natural history is observation and induction. Observation and its documentation involve symbolic communication and are thus not precise. But they can be made accurate and extensively reproducible. The hard sciences also contain considerable subjectivity. The selected measuring tools and associated hypotheses limit the scope, outcome, and applicability in these fields. Much science gets done to prove a point, and is not published unless it does. Interpretation of scientific studies involves even greater subjectivity. A critical observer need only follow the national debate on smoking or climate change to find examples of different interpretations of a set of observations.

Such studies are too time consuming for the purposes of evaluating potential restoration projects. On occasion, historic studies do exist; for example, if the COE were about to undertake a restoration of Walden Pond or the Colorado River. Often partial studies exist, such as the many stories of the Mississippi or the Everglades. The literature concerning a place may have influenced the choice of projects. *The River of Grass* played an important role in bringing the Everglades to public attention. Considerable literature describes the Chesapeake.

Similarly, nature writing has two contradictory intents: description and advocacy. On one hand, writers wish to describe some bit of natural history so that others may see it. They wish to add an objective description of some phenomena to our knowledge about the natural world. Writers attempt to get the facts. On the other hand, they want readers to support, enhance, enlarge, protect, or otherwise do something the authors believe is good. Writers are not objective. We always tell the truth, of course, but the truth is a construct flavored by the words we choose to use.

The students of nature, as John McPhee says, want to understand, organize and control nature. People construct an ordered nature for their own pleasure and convenience. Mankind will never be able to reconstruct natural systems in a predictable way. Restoration will always remain an art. Each place will behave in a slightly different fashion. Each place needs its reporters and documenters to tell what happened there. These collected chronicles will tell a variety of stories. The stories help readers develop a grounded reality, or at least a reality that looks generally the same to enough people that there is a confidence in the range of outcomes from a particular action.

The semantic problem is real. Two filters blur communication. The writer picks the best fitting word, which he or she knows for the meaning intended. The word or phrase will not be exactly right. There are no synonyms in English. No words are neutral. The word may carry extra implications. Then the readers filter the words through their own cognitive filters. They hear a slightly different meaning than the writer intended. Each person shades inferences of another's words. Each has these cognitive filters. They design themselves from experience and cultural background. Thus, the subjectivity versus objectivity dichotomy dissolves. Because of the symbolic nature of language, objectivity is diaphanous. All writing about nature, all descriptions, all propaganda is subjective.

During EPA's Natural History and Nature Writing Workshop, two views about nature writing emerged. Some thought that the perceptions and emotional responses of the writer were the focus of nature writing. The contrasting position believed that the primary role of nature writing was to describe nature as clearly as possible. The writer entered the story only after nature's story had been told.

Norman Maclean in *Young Men and Fire* describes the story of the Mann Gulch fire in Montana two ways. In 1949, eleven fire-fighters perished in the worst fire loss until the recent 1994 Colorado fire. First, he wrote the story as he read and heard it. Then, years later, Maclean undertook an intensive investigation of the Mann Gulch fire. He interviewed experts and the surviving participants and, though old and debilitated, revisited the site. Maclean attempted to reenact the tragedy. He measured the site extensively. He used the expert information to reconstruct several possible courses of the fire. He analyzed the scene as a detective. The first section was nature writing while the second section contained natural history. Each contains elements of the other. Both depend on what is there and what the writer perceives. Clearly, the writer's perceptions are colored by his emotional response to the natural event. While Maclean does not discuss his reason for such an intense interest decades after the event, evidence of his fixation permeates the second section.

From this discussion, it can be concluded that nature writing and natural history overlap necessarily and considerably. Nature writing may include work primarily derived from the author's own thoughts but stimulated by some natural event or phenomena. The "naturalness" of the event or phenomena is a construct of the author's mind and may include a range of subjects from human centered to much less so. The work may be fiction to nonfiction. Though in the context of constructed reality it is all fiction.

Natural history is a special case of nature writing which attempts to describe and analyze environmental phenomena using a variety of epistemological tools. Natural science uses qualitative and quantitative methods to construct general principles to describe the truths and facts of the natural world. These general principles emerge from theories which are tested and retested to establish their consistency and applicability. Natural science attempts to organize a view of the world of such agreement among experts that it provides the illusion of objectivity.

Journalism and the Media

Other projects are born out of catastrophic events. Restoration in the Mississippi floodplain became a national issue as a result of the recent floods. Hurricanes demonstrate the importance of the South Florida drainage systems. Often the media coverage of these catastrophic events contains grains of information about the ecological capacity of the system. These grains may contain the only data about the ecosystem under stress. These stories combine vignettes of people interacting with nature, under stress. Thus, journalism and the media at the time provide an array of nonquantifiable data about a potential project.

Ecological History Methods

1. **The Use of Written History**. A variety of documents are relevant: scientific reports, newspaper articles, historical accounts, personal memoirs, pictures, and maps.

2. **The Use of Oral Histories**. Follow archival research by interviewing members of the community with considerable first-hand experience on the site.

3. **The Use of Existing Scientific Information**. Existing scientific information is an essential form of the scientific record. Weather records, stream records, flood and drought events, fish censuses, water quality surveys, trapping records, logging, vegetation surveys, and any other records help interpret history.

4. **Current Studies Integrate and Calibrate Historical Observations**. Small local studies may be necessary to understand and use historic scientific and lay observations.

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